DOCTOR OF PHILOSOPHY

The impact of financial liberalisation on bank performance: international evidence on efficiency and productivity

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Award date:
2014

Awarding institution:
Coventry University

The Impact of Financial Liberalisation on Bank Performance: International Evidence on Efficiency and Productivity

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A thesis submitted in partial fulfilment of the University's requirements for the Degree of Doctor of Philosophy for PhD

Coventry University

March 2014

Abstract

This thesis provides international evidence relating to the impact of financial liberalisation on banking sector performance. Compared to a large number of studies linking financial liberalisation to economic growth and financial fragility, there is relatively little research at the international level linking financial liberalisation to banking sector efficiency and productivity. The research contributes to the literature by making a systematic, cross-country empirical investigation using domestic and international measures of financial liberalisation and evaluates their impact on bank efficiency and productivity by applying a combination of frontier estimation methods, dynamic panel data regressions and Granger causality techniques. The evidence is based on the use of bank-level accounting data and country-level economic data for a sample of 1536 commercial banks covering 88 countries over the period 2000 to 2009. Apart from using the global frontier for estimation of bank efficiency, empirical analysis is conducted across various levels including the use of separate income-group frontiers to determine the robustness of the findings.

Using stochastic frontier analysis (SFA) for the estimation of banks' cost and profit efficiency, the evidence shows that financial liberalisation contributes positively to profit efficiency while the effect on cost efficiency is generally mixed, depending on the measures of financial liberalisation used. Additionally, the results show that while cost efficiency remains, on average, stable during the estimation period (2000-2009), average profit efficiency fluctuates in the pre-crises period (2000-06) but declines sharply during the post crises period (2007-09). Furthermore, accounting explicitly for the influence of risk in banking, the evidence suggests that financial liberalisation, lower cost efficiency and higher profit efficiency of banks all increase the potential for default risk, while the latter also reduces both cost and profit efficiency, providing support for the bad management hypothesis. Additionally, upon accounting explicitly for the role of market power or competition in banking, the evidence suggests that both financial liberalisation and greater market power contribute to higher default risk of banks. On the other hand, greater competition in banking contributes to higher cost but lower profit efficiency of banks under financial liberalisation.

The cross-country empirical investigation is also extended to analyse the impact of financial liberalisation on banks' technical efficiency and productivity growth, using a two-step approach of combining data envelopment analysis (DEA) with panel data regressions. The evidence here suggests that financial liberalisation is robustly and negatively associated with (pure) technical efficiency. Furthermore, the effect on the total factor productivity (TFP) growth (using two-step DEA-type Malmquist method) is positive, although not always statistically significant.

The robustness analysis conducted across the different income groups (higher, upper-middle, lower-middle and lower) confirms that the impact on cost, profit and technical efficiency of banks is more pronounced in the more developed (higher and upper-middle) countries than in the less developed countries. In particular, the impact of financial liberalisation is largely insignificant in the lower income countries. This finding generally reflects the greater pace of capital account liberalisation in the higher and upper-middle income countries, where the impact on both cost and profit efficiency is positive. Throughout the analysis, the estimation takes into account country-specific differences in the regulatory, market structure, financial development and macro-economic conditions and the evidence shows that these influences are also mostly significant and robust under financial liberalisation. Hence, the thesis concludes by arguing that financial liberalisation exerts an independent effect on the cost, profit and technical efficiency of banks, while the risks associated with financial liberalisation should be mitigated with better regulatory and institutional structures.

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CHAPTER 1
INTRODUCTION

1.1 Overview and motivation

Over the last three decades the global financial market has witnessed a dramatic change due to the pace of financial liberalisation across the world which has led to a surge in cross-border capital flows, improvement in the flow of funds through the stock market, and development of financial intermediation associated with increased competition in the banking and non-bank financial sectors through financial deregulation. A large literature has explored the impact of financial liberalisation on economic growth (King and Levine, 1993; Beck et al., 2000; Levine, 2001) as well as on financial crisis (Kaminsky and Reinhart, 1999). In fact, the arguments about the dual impact of financial liberalisation on economic growth and financial fragility are well known. One strand of the literature highlights the beneficial impact of financial liberalisation suggesting that it enhances financial development and economic growth. For example, Levine (2001) argues that financial liberalisation not only promotes economic growth through improving the functioning of the domestic financial market but also through stock market liquidity and the efficiency of financial intermediation due to increased competition from the entry of foreign banks. Furthermore, other authors (Beck et al., 2000) suggest that financial liberalisation fosters financial development which translates positively into productivity growth and hence to higher economic growth.

On the other hand, latest episodes of financial crises suggest that financial liberalisation is not a risk free process. It is commonly argued that higher economic growth in developing countries has been associated with higher financial volatility leading to greater frequency of financial crises resulting from the relaxation of capital controls (associated with capital account liberalisation). The benefits of higher economic growth associated with financial liberalisation might therefore be reversed due to severe economic downturns that typically result from financial crisis, as happened with the

Mexican economic crisis in 1994, the East Asian financial crisis in 1997, the Argentine crisis in 2001, and so on. There is a lot of empirical evidence, at both individual country and cross-country levels, to support the link between financial liberalisation and financial fragility, and some of the recent studies focus on the banking sector, linking financial liberalisation to the increased likelihood of banking crises in liberalised financial systems (Detragiache and Demirgüç-Kunt, 1998; Angkinand et al., 2010). Furthermore, these and other authors suggest that the likelihood of banking crises in liberalised financial systems is induced by the excessively risky behaviour of banks which strive to maintain their profitability in a more competitive environment (Hellmann et al., 2000; Ranciere et al., 2006).

From the discussion above, the dual effects of financial liberalisation are therefore clear: firstly, financial liberalisation promotes economic growth or productivity through higher capital accumulation (direct effect) or via improvements in the functioning of financial markets (indirect effect); secondly, financial liberalisation also increases the likelihood of financial fragility, especially banking crises, which may be associated with excessive risk-taking by banks in a more competitive environment. However, if we focus narrowly on the impact of financial liberalisation on the banking sector, the evidence seems to suggest that there is an apparent paradox. Intuitively, the banking sector should benefit from financial liberalisation as a result of greater efficiency in the allocation of financial assets, implying more efficient banking or stock market operations. In reality, banks have suffered from greater frequency of failures in liberalised financial systems. While some studies have addressed the latter issue, namely the impact of financial liberalisation on banking crises (Detragiache and Demirgüç-Kunt, 1998; Angkinand et al., 2010), there is comparatively limited research on how banking systems have performed under the influence of financial liberalisation. For instance, whether bank efficiency or productivity has improved across the globe particularly over the past decade and, if so, what aspects of financial liberalisation or the market environment have contributed to it?

The purpose of this study is to examine the impact of financial liberalisation on banking sector performance, as measured in terms of efficiency and productivity. In contrast to established evidence (discussed in Chapter 2) relating to the impact of financial liberalisation on economic growth and financial fragility (or banking crises),

there is relatively limited research, particularly at the international level, relating to the impact of financial liberalisation on banking sector performance. The extant literature (discussed in Chapter 3) comprises mainly of individual country studies highlighting the impact of pre- and post- financial liberalisation periods on bank efficiency (Ataullah et al., 2004) or productivity (Gilbert and Wilson, 1998; Isik and Hassan, 2003). In addition, a limited number of cross-country studies have focussed on specific regions, such as the transition economies of Eastern Europe (Bonin et al., 2005), Latin American and Asian countries (Hermes and Nhung, 2010)[1]. Hence, there is a need to conduct a systematic investigation of the impact of financial liberalisation on banking sector performance, taking account of the different aspects of financial liberalisation policies that have pursued over the past decade for which data is readily available across a broad cross-section of countries. In this context, this research applies the recent datasets on financial liberalisation indicators developed by Chinn and Ito (2008), Kose et al. (2009) and Abiad et al. (2008). Some recent studies have employed these data to investigate their impact on economic growth (Bekaert et al., 2005), productivity (Bekaert et al., 2011), financial development (Baltagi et al., 2009), and banking crises (Angkinand et al., 2010), while this study seeks to apply these data to investigate banking sector performance.

How does financial liberalisation affect banking sector performance? One of the consequences of opening up the economy to foreign capital or the entry of foreign banks is to introduce greater competition in the domestic banking sector which forces banks to engage in greater risk taking in order to improve their performance, and higher efficiency or productivity could be associated with higher risk taking incentives for banks although the latter may also lead to higher incidence of banking crises. While excessive risk-taking is considered to be one of the main reasons for bank failures in the recent global financial crisis of 2007-09, some studies have also examined the relationship between risk taking and banking efficiency (Altunbas et al., 2007; Fiordelisi et al., 2011), although these studies do not consider explicitly the influence of financial liberalisation which represents

[1] Bonin et al (2005) analyse the effect of ownership on bank performance as a result of privatisation of the Banking system in specific Central and Eastern European countries, which is just one aspect financial liberalisation. Hermes and Nhung (2010), by way of exception, analyse impact of financial liberalisation on the technical efficiency of banks in Latin America and Asia regions using a DEA approach. However, as noted further below, their use of the financial liberalisation index, based on six dimensions dummy, is rather limited since better measures of financial liberalisation have been introduced recently (e.g. Abiad et al, 2008).

a change in the external environment of the economy. Additionally, there are recent studies that have emphasised the importance of the role of regulation in influencing various aspects of banking performance such as profitability (Naceur and Omran, 2011), efficiency (Pasiouras, 2008; Pasiouras et al., 2009) and productivity (Delis et al., 2011). However, the extant literature has not examined explicitly the connection between financial liberalisation, risk-taking, regulation and banking sector performance. For example, financial liberalisation may influence banking performance through greater competition in the banking sector because of the entry of foreign banks or capital inflows which, in turn, may induce excessive risk taking by banks in order to maintain their profitability eroded by higher competition (Keeley, 1990). To what extent these risk taking incentives of banks influence the performance efficiency or productivity of banks is still an open question, and so far there is very limited evidence, especially at cross-country level, relating to the overall impact of financial liberalisation on the banking sector either directly through the efficient function of financial markets or indirectly through greater competition and risk taking, in contrast to comparable evidence that exist on banking sector crises. Turning to the specific characteristic of banks, banks are more inclined to take on greater risk due to moral hazard because of limited liability they face for their higher leverage and equity holdings Stiglitz (1972). This is due to explicit and implicit guarantees such as the existence of safety nets and deposit insurance which tend to increase bankers' appetite for risk beyond what is socially desirable (Demirgüç-Kunt and Detragiache, 2002). In attempting to investigate the efficiency and productivity of banks under financial liberalisation, this study considers these special characteristics of banks and their regulatory and operating environments.

1.2 Research aim, research questions and objectives

The research aims to provide international evidence relating to the impact of financial liberalisation on banking sector efficiency and productivity, taking account of the special characteristics of banks associated with safety nets and the natural appetite for banks to engage in greater risk taking that results from a change in their operating environment induced by financial liberalisation. Assuming that financial liberalisation impacts upon banking sector performance through the efficient functioning of financial

markets or other channels, and considering the complex inter-linkages or trade-offs that might exist in the relationship between liberalisation, risk-taking, competition and banking performance, the study undertakes a systematic, cross-country empirical investigation to address four main research questions:

1. How does the impact of financial liberalisation on banking sector performance (as measured by efficiency or productivity) differ across different economies? Does economic development matter in this context?

Research conducted at cross-country level typically accounts for differences in the degree of development level across economies. Previous research at cross-country level suggests that financial liberalisation contributes positively to economic growth (King and Levine, 1993; Bekaert et al., 2005; Ben Naceur et al., 2008) as well as total factor productivity (TFP) growth (Kose et al., 2009; Bekaert et al., 2011), although the effect varies across different economies. The level of economic development matters according to the study by Ranciere et al. (2008), who indicate that financial liberalisation has a greater impact on economic growth in middle-income countries than in higher-income countries, and does not have much impact in lower-income countries. In banking, the literature has addressed the impact of developmental level on bank efficiency associated with off-balance sheet activities (Lozano-Vivas and Pasiouras, 2010), as well as the impact of development associated with regulatory and policy environments on bank efficiency and productivity (Pasiouras, 2008; Pasiouras et al., 2009; Delis et al., 2011; Barth et al., 2013; Gaganis and Pasiouras, 2013). In line with these studies, this research aims to conduct a systematic cross-country investigation of the impact of financial liberalisation in order to account of the importance of economic development while controlling for differences in regulatory, macroeconomic and environmental conditions.

2. Do various regulatory or market-related factors (e.g. financial depth and competition) have an impact on bank efficiency or productivity and, if so, how significant are these influences under financial liberalisation?

As noted above, a number of studies have addressed, at cross-country level, the issue of the impact of regulations on bank performance (Pasiouras, 2008; Pasiouras et al., 2009; Barth et al., 2013), and the impact of competition on bank performance (Casu and Girardone, 2006; Schaeck and Cihak, 2008; Delis and Tsionas, 2009), and the impact of foreign ownership or investment on bank performance (Lensink et al, 2008; Tanna, 2009). These studies complement numerous individual-country studies on banking efficiency or productivity that account for the influence of various market related factors, such as the effect of foreign bank entry (Matthews and Ismail, 2006; Sensarma, 2006), privatisation (Bonaccorsi di Patti and Hardy, 2005; Nakane and Weintraub, 2005; Berger et al., 2009), and market power (Worthington, 1999; Mukherjee et al., 2001; Tirtiroglu et al., 2005). In studying the impact of financial liberalisation on banking performance, the present study adds to the literature by investigating the impact of various regulatory and market-related factors by incorporating them as control factors in cross-country regressions and assessing whether these influences prevail under financial liberalisation.

3. Considering the specific characteristics of banks, in particular the importance of moral hazard associated with bank risk-taking, is there a trade-off between the impact of financial liberalisation and risk on bank efficiency? In other words, accounting for limited liability that banks face through deposit insurance schemes, are any causal inferences to be drawn between financial liberalisation, risk-taking and efficiency?

As the discussion above suggests, greater risk taking by banks provides a channel though which financial liberalisation could affect bank efficiency. In this respect, the relationship between financial liberalisation and efficiency might be affected by the default risk of banks. The banking literature has studied the relationship between risk and efficiency (Berger and DeYoung, 1997; Kwan and Eisenbeis, 1997; Moon and Hughes, 1997; Girardone et al., 2004; Altunbas et al., 2007; Fiordelisi et al., 2011). Furthermore, the literature indicates that the existence of deposit insurance scheme reduces market discipline (Demirgüç-Kunt and Huizinga, 2004; Imai, 2006) and increases the likelihood of banking crises (Demirgüç-Kunt and Detragiache, 2002; Demirgüç-Kunt et al., 2005). In studying the relationship between financial liberalisation, risk and bank efficiency, this

study accounts explicitly for the influence of deposit insurance and its potential consequences on the default risk of banks.

4. Given the environment in which banks operate, typically with a degree of market power, the final research question asks whether the effect of financial liberalisation on bank efficiency prevails when accounting for the role of competition (or market power).

This research question will therefore extend the empirical analysis by drawing on the literature examining the relationship between competition and bank efficiency (Claessens and Laeven, 2004; Fernandez de Guevara et al., 2005; Schaeck and Cihak, 2008; Casu and Girardone, 2009), as well as the literature that examines the relationship between competition and risk (Schaeck and Cihak, 2008; Turk Ariss, 2010). The link between financial liberalisation and competition in banking has recently been studied by Delis (2012) who shows that financial liberalisation reduces the market power of banks in developed countries with advanced institutions. It is expected that financial liberalisation policies will enhance competition in the banking sector which in turn will induce banks to excessive risk taking; subsequently, this can lead to greater default risk and undermine the efficiency of banks. In such explanation, competition provides a transmission mechanism through which financial liberalisation influences bank efficiency through greater risk-taking. This research will therefore extend the investigation further by assessing whether the impact of financial liberalisation on bank efficiency is influenced by the degree of competition in the market and how this affects the causal relationship between financial liberalisation, risk and efficiency.

In pursuing the above research questions for empirical investigation, it is important to first identify the main measures of financial liberalisation for which data is available and implement the relevant techniques for measuring bank performance. In relation to the former, there is an established literature which has studied the impact of financial liberalisation on economic growth and financial fragility. Thus, it is essential to review this literature and identify the main dimensions of financial liberalisation policies that

have been employed in this literature. With regard to the measurement of bank performance, the banking literature has studied extensively frontier efficiency and productivity methods to determine different measures of bank performance. Thus, this research makes a contribution by drawing on these two literatures which have evolved largely separately, although as noted above there have been a limited number of studies, mainly at the individual country or regional levels, which have investigated the impact of financial liberalisation on banking efficiency and productivity. The main contribution of this research is to conduct a systematic, cross-country investigation of the impact of various financial liberalisation policies on different measures of bank performance incorporating frontier efficiency and productivity methods, supplemented by panel data regression and Granger causality techniques to examine the robustness of the impact of financial liberalisation on banking sector performance.

In summary, the main research objectives of the thesis are:

1. Review of the broad literature relating to the impact of financial liberalisation on macroeconomic as well as banking sector performance. The extant literature studying the impact of financial liberalisation on economic growth and financial fragility is extensive and is reviewed broadly with a view to analysing the measurement aspects of financial liberalisation. The review of the literature on banking sector performance is more specific and confined to studies that relate aspects of financial liberalisation and regulation to banking sector efficiency, productivity growth and risk.

2. Analysis of the main methodologies for frontier efficiency estimation, both parametric and nonparametric, in order to apply them to subsequent empirical analysis, which include computing cost, profit and technical efficiency as well as total factor productivity change in cross-country samples of commercial banks. The methodologies studied include stochastic frontier analysis (SFA) for estimation of cost and profit efficiency, data envelopment analysis (DEA) for estimation of technical efficiency, and DEA-type Malmquist index for estimation of total factor productivity change. Additionally, the efficiency estimates are subsequently employed in panel data regressions supplemented

by Granger causality analysis to identify causal links and the significance of bank and country level factors.

3. Empirical analysis to address the aforementioned research questions, which are to:

(i) Assess the impact of financial liberalisation on banking sector performance at cross-country level in order to account for different levels of economic development while controlling for cross-country differences in the regulatory and market environments.

(ii) Evaluate the significance of regulatory and market related factors in assessing the importance of financial liberalisation on bank efficiency and productivity.

(ii) Examine the impact of financial liberalisation on bank cost, profit and technical efficiency, while accounting specifically for the role of moral hazard in banking by incorporating the role of deposit insurance schemes and default risk while controlling for regulations and institutional quality.

(iii) Extend the investigation further by considering the specific environment in which banks operate, by incorporating the degree of market power into the estimation of bank efficiency and analysing the Granger causality links between financial liberalisation, competition, risk-taking and efficiency.

1.3 Importance and contributions of the study

The importance of this study can be analysed from three main perspectives:

1.3.1 Studying banks and frontier efficiency estimation

The efficient operation of financial intermediaries and the efficient functioning of the financial intermediation process are crucial for economic growth owing to the established support for the finance–growth nexus that was first introduced by Schumpeter (1911) and later expounded by McKinnon (1973) and Shaw (1973). In broad terms, the finance-growth nexus works through the efficiency of banking operations which makes

for better financial resources allocation, which in turn promotes investment and economic growth. Consequently, in light of this basic premise about the importance of finance for economic growth, a number of important studies have provided supportive empirical evidence, at firm, industry and country levels, for the positive relationship between financial development and economic growth (Levine and Zervos, 1998; Rajan and Zingales, 1998; Beck et al., 2000). In fact, the initial impetus behind the drive for financial liberalisation across the world was partly the growing support for the established relationship between financial liberalisation, financial development and economic growth, stemming from the contributions of Mackinnon (1973) and Shaw (1973). Banks in the process have played a dominant role in facilitating the financial intermediation process, transmitting the economy's national savings into productive investment opportunities.

While financial liberalisation has caused a decline of traditional bank services that transform money from lenders to borrows, banks still continue to play a dominant financial intermediation role in most of the countries. Moreover, the activities of banks have themselves become more heterogeneous and diversified to include non-traditional activities, since financial liberalisation policies generally involve relaxation of restrictions on bank activities. On the other hand, as argued above, financial liberalisation leads to greater frequency of financial and banking crises. Such crises are expensive not only because of associated large fiscal costs of crises resolution for the tax payers, but also they have the severely adverse recessionary impact on the economy. Hence, efficiency of the banking system is crucial in ensuring sustained growth through financial liberalisation.

The importance of this study can therefore be seen by evaluating the significance of the impact of financial liberalisation on banking efficiency and productivity. In this study, the measurement of bank efficiency and productivity as proxies for bank performance is done through frontier efficiency methods (e.g. SFA and DEA). In principle, frontier efficiency methods seem to be better able to capture the function of banks, allocating funds to productive, by combining relevant inputs and outputs into the production process. This study uses both stochastic frontier analysis (SFA) and data development analysis (DEA) to evaluate separate measures bank efficiency using multiple inputs and outputs to assess the efficiency of resource utilization, as opposed to

traditional financial ratios such as return on asset (ROA) and return on equity (ROE). Berger and Humphrey (1997) suggest that frontier approaches are better than using traditional financial ratios.

1.3.2 Importance of cross-country analysis

There are three reasons for studying cross-country analysis.

First, financial liberalisation is a "global" phenomenon which emerged in the 1970s, when most of the developing countries around the world started liberalising their financial systems. The discussion of cross-country trends of financial liberalisation in Chapter 2 reveals that, particularly over the past decade, more developed countries (high and upper-middle income group) countries have experienced higher levels of financial liberalisation than less well developed countries (lower-middle and lower income groups). It is therefore important to assess the impact of financial liberalisation at cross-country level to assess if the effect on the banking sector also differs across these economies.

Second, financial liberalisation policies generally involve relaxing the entry barriers to foreign firms, increase capital mobility across countries, improve credit allocation by removing interest rate ceilings and activity restrictions, and divest the assets of the state through privatisation. All these factors highlight the importance of the developmental level of the country in which banks are made to compete fiercely in the globalized world and engage in greater risk taking to confront the pressures of more intensified global competition. In these circumstances, the measurement of bank efficiency at cross-country level allows us to assess the impact of financial liberalisation on bank efficiency across different levels of economic development (by classifying countries into different income groups) as well as to assess the significance of this impact to different regulatory and environmental factors.

Third, most of the previous studies are mainly individual country-level studies assessing the impact of financial liberalisation on bank efficiency by analysing the period before and after financial reforms without invoking any quantity measure of the degree of financial liberalisation (Gilbert and Wilson, 1998; Isik and Hassan, 2003; Ataullah et al., 2004). This study utilise a comprehensive set of indices to reflect the different dimensions of financial liberalisation and provide cross-country evidence covering the

recent decade of financial liberalisation from 2000 to 2009, encompassing the global financial crisis of 2007-09.

1.3.3 Importance of accounting for special characteristics of banks

In assessing the impact of financial liberalisation on bank efficiency, this study allows for the importance of risk, the role of deposit insurance, and the market environment in which banks operate to analyse whether these factors have a significant impact on bank efficiency under financial liberalisation. Previous research indicates that financial liberalisation or deregulation induces greater competition and excessive risk-taking. On the one hand, financial liberalisation induces intensive competition in the banking sector that forces banks to operate more efficiently; while, on the other hand, intensive competition erodes charter value and profits of banks and such pressures induce banks to take more risky portfolios (excessive risk behaviour) in order to maintain the profits. Hence, a trade-off exists between financial liberalisation, efficiency and risk. Furthermore, the existence of deposit insurance creates a moral hazard problem for banks by limiting their liability under default. These specific characteristics of banks make them unique. There are a number of studies which investigate the relationship between risk and efficiency (Berger and DeYoung, 1997; Altunbas et al., 2000; Altunbas et al., 2007; Fiordelisi et al., 2011). However, to the best of author's knowledge, there has been no empirical study which investigates the relationship between deposit insurance, risk and bank efficiency under financial liberalisation.

1.4 Summary of main contributions

There are three main contributions of this study.

First, to the best of the author's knowledge, this is the first study to investigate the impact of financial liberalisation on banks' cost and profit efficiency using the parametric frontier approach (SFA), while providing cross-country evidence. In this context, this study also utilises a comprehensive set of indices to measure different dimensions of financial liberalisation and conduct robustness analysis across different levels of economic development associated with advanced, middle-income and low-income group of countries. Furthermore, this research also employs the non-parametric frontier

approach (DEA) and analyses the influence of financial liberalisation on banks' technical efficiency and total factor productivity change at cross-country level, extending the analysis of previous studies which have focussed either at regional or individual country level (Isik and Hassan, 2003; Ataullah et al., 2004; Hermes and Nhung, 2010).

Second, the study extends the analysis of cost, profit and technical efficiency by incorporating the special characteristics and environment in which banks operate, allowing for the role of deposit insurance, default risk and market competition to influence bank efficiency. In this context, the study combines the methodology of frontier efficiency estimation with dynamic panel data regressions and Granger causality analysis to identify the channels through financial liberalisation affects bank efficiency. This builds on the methodological approach of Fiordelisi et al. (2011) and extends the empirical scope to include the influence of financial liberalisation on efficiency through risk, and of financial liberalisation on risk through competition.

Finally, the study attempts to provide comprehensive cross-country empirical evidence of the impact of financial liberalisation on bank efficiency using recently available data on measures of financial liberalisation covering both *de jure* (policy based) and *de facto* (outcome based) measures. This extends the scope of previous studies on bank efficiency which have employed largely dummy variable measures of financial liberalisation. Additionally, the empirical analysis in this study covers from 2000 to 2009 which includes the 2007-09 financial crises.

1.5 Outline of the thesis

Apart from this introductory chapter, the structure of the thesis is as follows:

Chapter 2,"**Financial Liberalisation: Growth, Fragility and Measurement**", provides a broad review of the conceptual issues, theoretical arguments and empirical evidence linking financial liberalisation to economic growth and financial crises, leading to a discussion of various measurements of financial liberalisation.

Chapter 3, "**Financial Liberalisation and the Banking Sector**", provides a review of the literature on bank risk taking, efficiency and productivity before discussing studies linked with financial liberalisation.

Chapter 4, "**Research Methodology**", discusses frontier efficiency estimation approaches mainly referring to the parametric (SFA) and the non-parametric (DEA) approach as well as the DEA-type Malmquist method for estimation of total factor productivity change.

Chapter 5, "**Cost and Profit Efficiency of Banks under Financial Liberalisation**", analyses the impact of financial liberalisation on bank cost and profit efficiency using the one-step SFA approach of Battese and Coelli (1995) while controlling for bank and country level heterogeneity including differences in regulations, market structure, financial development and macroeconomic conditions.

Chapter 6, "**Impact of Financial Liberalisation on Technical Efficiency and Productivity Growth**" analyses impact of financial liberalisation on banks' technical efficiency and productivity growth using the two-step DEA approach and Malmquist productivity index.

Chapter 7, "**Accounting for the role of Risk and Institutional Quality in the estimation of Bank Efficiency under Financial Liberalisation**", extends the analyses of Chapters 5 and 6 by incorporating the role of deposit insurance and default risk while controlling additionally for institutional quality, with methodology supplemented by dynamic panel data estimation and Granger causality analysis to identify causal links between financial liberalisation, risk and efficiency.

Chapter 8, "**Accounting for the role of Competition and Risk**", extends the analyses of Chapters 5 and 6 by including the effect of market competition and risk, supplemented by dynamic panel data estimation and Granger causality analysis to identify causal links between financial liberalisation, competition and risk.

Chapter 9, "**Conclusion**", presents a summary of the main findings and discusses some policy implications and avenues for further research.

CHAPTER 2

FINANCIAL LIBERALISATION: GROWTH, FRAGILITY AND MEASUREMENT

2.1 Introduction

This chapter discusses the conceptual issues as well as some of the theoretical arguments and empirical evidence linking financial liberalisation to economic growth and financial fragility. The purpose of this chapter is to provide a basic understanding of the concept of, and motives for, financial liberalisation as it relates to macroeconomic performance: growth and fragility, where a large literature on financial liberalisation has developed. It is hoped that broader discussion of the literature on financial liberalisation and the historical context in which it has evolved over the past few decades will provide a useful perspective for analysing the various measures of financial liberalisation that have been developed over the years and identifying the main types of financial liberalisation policies have been implemented across the world.

The concept of financial liberalisation became popular with the seminal works of McKinnon (1973) and Shaw (1973). Both these authors independently argued that financial repression impeded economic growth and advocated the use of financial liberalisation as a mechanism for promoting economic development. There is now ample evidence to suggest that financial liberalisation contributes to economic growth not only by increasing the quantity and quality of investments but also by improving the functioning of the financial markets. However, experience has shown that financial liberalisation also induces greater volatility in output and credit and makes the economy more vulnerable to financial crises. In order to analyse the arguments and evidence pertaining to both sides of this debate about the consequences of financial liberalisation, the discussion in this chapter is divided into 6 sections: Section 2.2 presents the

background, concepts and motives of financial liberalisation, as they emerged from the contributions of McKinnon (1973) and Shaw (1973); Section 2.3 then analyses the theoretical contributions and evidence relating to the impact of financial liberalisation on economic growth; Section 2.4 analyses the same with regard to the effects of financial liberalisation on financial crises; Section 2.5 describes the measurement issues and the trends of financial liberalisation; Section 2.6 is conclusion.

2.2 Financial liberalisation: background, concepts and motives

2.2.1 Concepts of financial repression and financial liberalisation

The concept of financial liberalisation gained prominence from the seminal works of McKinnon (1973) and Shaw (1973), who argued that *financial repression* undermined economic growth in developing countries and proposed the use of *financial liberalisation* policies to promote savings, investment and economic growth. They defined the prevailing use of *financial repression* as a set of government imposed regulations, laws and policies which prevented financial intermediaries from functioning at their full capacity. In a survey on financial liberalisation, Williamson and Mahar (1998) identify six main features of financial repression: (i) interest rate ceilings on bank deposits and lending, (ii) high reserve requirements, (iii) state ownership of banks, (iv) restrictions on capital flows between domestic and foreign financial markets; (v) entry barriers on the development of financial intermediaries, which restricted competition in the banking sector and led to existing banks occupying monopoly positions; and (vi) governments controls on credit allocation that led to credit flowing into certain priority sectors where governments extracted high profits from economic rents. In contrast, the advocacy of *financial liberalisation* meant that governments had to relax these controls and thereby reduce their scope to intervene in financial markets[2].

[2] Beim and Calomiris (2000) discuss these six dimensions relating to the implementation of financial liberalisation policies, namely deregulation of interest rates, lowering of bank reserve requirements, elimination of controls on credit, relaxation of entry barriers to the banking sector, privatization of state-owned banks, and promoting international capital flows.

2.2.2 From financial repression to financial liberalisation

McKinnon (1973) and Shaw (1973) argue that the key motivations behind the financial repression policies of preceding decades were to maintain the stability of the financial system, increase government revenue, and protect the domestic monopolies. In this context, the entire financial system of the economy was considered as a tool of the treasury, where governments extracted revenue for their fiscal needs from the public through issuing of government debt. For example, they imposed interest rate ceilings to keep nominal interest rates low in order to reduce the debt servicing costs, and took advantage of using money supply to raise inflation in order to reduce the real value of government debt, reaping seigniorage and yielding negative real interest rates (Reinhart and Sbrancia, 2011). Thus, governments could borrow money to finance their fiscal deficit through lower nominal interest rate, while at the same time collect revenue from seigniorage and also taxing interest payments on government bonds. This raised substantial revenue and lowered the costs of the government borrowed funds (Giovannini and Melo, 1993; Gupta and Lensink, 2002). On the other hand, lower nominal interest rates did nothing to encourage savings, which was the main source of investment in developing countries, since the capital markets were not well developed. Furthermore, the credit funds were usually allocated to specific industries with privileged access for government loans, which created monopoly profits for the government. As a result, private incentives for investment were distorted due to lack of sufficient funds. Additionally, foreign exchange controls limited international capital mobility which made financial resource allocation inefficient. Overall, financial repression policies failed to encourage private savings, distorted investment opportunities, and impeded economic growth.

In contrast, the advocacy of financial liberalisation was intended to make the financial system more efficient by improving the efficiency of resource allocation from savings into investment. McKinnon (1973) and Shaw (1973) suggested the mechanism through which financial liberalisation would encourage more investment was to remove the interest rate ceiling so that the interest rate is determined by market conditions, and a rise in the interest rate would encourage greater private savings that would give banks more funds, through greater savings, to lend to borrowers who would invest in profitable

projects. Furthermore, relaxing capital controls and removing entry barriers would encourage foreign investment in the domestic economy and allow foreign banks and other non-bank financial institutions to compete in domestic financial markets, thus increasing market competition and stimulating financial development. The increase in domestic investment might create further incentives on the supply side to promote productivity. Ultimately, financial liberalisation would improve the efficiency of capital allocation, leading to higher economic growth and also contributing to greater financial development. It should be noted that this effect may operate not just through deregulation of the interest rate, but also through the relaxation of capital controls and removal of entry barriers while privatisation and elimination of domestic credit control may serve to raise the incentives form the supply side.

It should be noted that financial liberalisation is distinguished from financial development (Abiad et al., 2008; Gehringer, 2013). While financial liberalisation refers to policies which require the governments to refrain from intervention in the financial markets, financial development on the other hand implies the capacity of the economy to increase the quantity and quality of financial transactions, thus leading to greater size and depth of the financial sector. However, there is an inherent relationship between the two, in that the former leads to the latter, as has been recognised in both theoretical and empirical studies (McKinnon, 1973; Shaw, 1973; Demetriades and Luintel, 1997; Arestis et al., 2002).

2.3 Financial liberalisation and economic growth

There is a large theoretical and empirical literature investigating the relationship between financial liberalisation and economic growth. The main conclusion that can be drawn from the literature is that financial liberalisation promotes economic growth through its effect on financial development via the availability of finance for investment projects both directly through the equity market and indirectly through financial intermediaries such as the banking sector. Additionally, the efficiency of capital allocation is improved through better monitoring, risk sharing and pooling of funds, which therefore aids economic growth. This section summarises the channels though

which financial liberalisation influences economic growth, presenting the main theoretical arguments and supportive empirical evidence.

2.3.1 Financial liberalisation and the efficiency of capital allocation

To understand the beneficial impact of financial liberalisation on economic growth, it is useful to begin by first showing how financial liberalisation improves the efficiency of capital allocation as it originated from the famous McKinnon-Shaw model. As noted above, McKinnon (1973) and Shaw (1973) illustrate the benefits of financial liberalisation by removing the interest rate ceiling so that interest rate is determined by a competitive market. Raising the interest rate therefore attracts more savings that induces more investment and mitigates the distortionary effect of lower interest rate.

Figure 2-1 describes the basic mechanism behind the McKinnon-Shaw model. When real interest rate is low at *r0* in a repressed financial system, the supply of savings is also at low at *s0*. Both saving and investment are therefore constrained in this system. After the removal of nominal interest rate ceiling, real interest rate is raised from *r0* to *r1*, and correspondingly savings is raised to *s1*, while *r2* describes equilibrium where savings are sufficiently high to meet the demand for investment, so that the interest rate is determined by the market. Thus, the McKinnon-Shaw model illustrates that financial repression prevents the financial market from serving its allocation function efficiently. In contrast, with financial liberalisation the increase in savings to meet the demand for investment might create opportunities on the supply side to promote growth and productivity. Ultimately, financial liberalisation would improve the efficiency of capital allocation, leading to higher economic growth and also contributing to greater financial development.

Figure 2-1 McKinnon-Shaw model: Saving, Investment and Interest Rate

However, subsequent studies have criticised the McKinnon-Shaw hypothesis arguing that it may not work between money and physical capital (as between physical capital and other forms of assets) as the negative real interest rate yields pressure on inflation that affects the purchasing power of domestic currency. The main argument is that the change in the demand for financial assets is not highly sensitive to the change in the deposit interest rate (Fry, 1980; Gupta, 1987)[3].Hence, the relationship between savings and investment is ambiguous.

Theoretically, however, financial liberalisation can improve the efficiency of capital allocation without necessarily leading to capital accumulation, so that growth may still result (Levine, 2001). In particular, the development of the financial system plays an important role in transmitting the effects of financial liberalisation to economic growth via efficient capital allocation. According to Levine (1997, 2001), Schumpeter (1911) and Bagehot (1873) were the early contributors who emphasised the idea that the main function of the financial system is to facilitate the mobilisation of capital and the management of risks that financial intermediaries create by supplying credit to business,

[3] Gupta (1984) investigates empirically this relationship for 23 countries of Asia and Latin America using 2SLS estimation and in simultaneous regression models. He concludes that the change in the demand of financial assets is not highly sensitive to the change in the deposit interest rate.

ultimately transmitting money to purchasing power in a well-functioning financial system to drive economic growth.

2.3.1.1 Financial intermediation: the role of banks

Levine (2001) identifies three channels through which financial intermediaries contribute to economic growth via better capital allocation. Firstly, financial intermediaries reduce the costs of collecting information about the firms (Diamond, 1984; Boyd and Prescott, 1986). Evaluating projects is difficult and incurs high costs for individual firms, but financial intermediaries are able to reduce such costs through better monitoring and avoiding duplication of efforts and free rider problems, thus improving the efficiency of capital allocation and thereby affecting long-term economic growth (Greenwood and Jovanovic, 1989). Secondly, financial intermediaries are able to improve risk sharing and management across time and space and thus lower transaction costs. Due to information asymmetry between savers and borrowers, financial intermediaries are more capable than individual investors in evaluating the risks of investment. Thirdly, intermediaries play an important role in the saving to investment mobilisation process; financial intermediaries such as banks can pool funds from disparate savers, and lend them to borrowers, thereby economising on transaction costs. In addition, some of the profitable projects require long-term funding support, but investors normally keep their savings for short term. Financial intermediaries transfer such short-term depositors' funds into long-term capital commitment and face risks in doing so, but are able to diversify their risks. Therefore, financial intermediaries improve the efficiency of capital allocation via reducing the information costs, risk diversification and saving mobilization and thus contribute to greater efficiency of capital allocation and long-term economic growth.

2.3.1.2 The role of the stock market

Levine (2001) also highlights three channels through which well-functioning stock market contributes to economic growth via efficiency of capital allocation. Firstly, through improved information and more liquidity in the stock market, there is greater incentive for managers to spend resources in researching firms and improve resource

allocation (Holmström and Tirole, 1993). Resource allocation thus benefits from improvement of information and liquid stock markets which indirectly contributes to economic growth. Secondly, well-functioning stock markets stimulate greater corporate control through takeovers (Jensen and Meckling, 1976) and through linking management compensation to performance (Jensen and Murphy, 1990). Thus, well-functioning stock markets can improve resource allocation via improvement in managerial incentives. Thirdly, stock markets can affect risk diversification and reduce liquidity risk (Bencivenga and Smith, 1991). Well-functioning stock markets make agents easier to construct their portfolios and make long-term investment more attractive, allowing agents and savers to trade their equities faster and cheaply.

2.3.2 Evidence on financial liberalisation and allocation efficiency

There are a number of empirical works which find that financial liberalisation improves capital allocation efficiency (Cho, 1988; Galindo et al., 2007; Abiad et al., 2008; Kukenova, 2011). For example, Cho (1988) finds a substantial improvement of credit allocation efficiency since 1980, when the Korean government started implementing financial liberalisation policies. Galindo et al. (2007) construct a summary investment allocation efficiency index using sales or profits per unit capital of listed firms and find strong positive relationship between financial liberalisation and allocation efficiency in 12 developing countries. Abiad et al. (2008) show similar findings in the allocation efficiency using dispersion in marginal expected returns to capital across listed firms in five emerging markets. Kukenova (2011) examines the relationship between stock market liberalisation and allocation efficiency using export data at firm level across 91 countries based on a trade theory perspective, and her results show that liberalisation induced a rebalance in the composition of the country's export portfolio though the products that used intensively the economy's abundant factors, hence leading to an improvement in allocation efficiency.

2.3.3 Evidence on financial liberalisation and TFP growth

Ranciere and Tornell (2011) present a theoretical model to support the view that financial liberalisation contributes to economic growth via total factor productivity

growth, as a result of more efficient capital allocation. Various empirical studies find supportive evidence to show that financial liberalisation influences economic growth though total factor productivity growth rather than capital accumulation (Bonfiglioli, 2008; Kose et al., 2009; Bekaert et al., 2011; Gehringer, 2013). Bonfiglioli (2008), for example, who finds a positive relationship between financial liberalisation and total factor productivity (TFP) growth in cross-country data covering 70 countries using both *de jure* and *de facto* financial liberalisation indicators. Kose et al. (2009) find that the *de jure* measure of financial liberalisation has a robust positive impact on TFP, while the impact of their *de facto* financial liberalisation measure on TFP is not clear. Bekaert et al. (2011) also conclude that financial liberalisation has a positive impact on TFP growth, arguing that such effects come through promoting the development of stock market, banking sector, institutional quality, and higher investment efficiency. A similar conclusion is reached by Gehringer (2013) in her review of financial liberalisation and TFP growth with evidence from EU countries.

2.3.4 Evidence on financial liberalisation and financial development

There is a now an established body of empirical work, both within country and cross-country level, supporting a positive relationship between financial liberalisation and financial development (Demetriades and Luintel, 1996,1997; Arestis et al., 2002; Chinn and Ito, 2006; Klein and Olivei, 2008). Among country-level studies, Demetriades and Luintel (1996) (for Nepal) and Demetriades and Luintel (1997) (for India) conclude that removing entry barriers leads to banking sector expansion with a significant positive impact on financial development. With regard to cross-country studies, Arestis et al. (2002) conclude that while interest rate liberalisation contributes to financial development, the impact varies with cross-country institutional differences. Chinn and Ito (2006) examine whether financial development benefits from financial liberalisation using panel data for 108 countries, and find that stock market development is significantly enhanced if it is accompanied by appropriate legal and institutional systems designed to achieve a minimum threshold level. Similarly, Baltagi et al. (2009) find that that financial openness (along with trade openness) has a significant impact on banking sector development.

2.3.5 Evidence on finance and growth

While financial liberalisation is distinct from financial development, the process through which the former affects economic development is invariably though greater financial development or deepening[4], as supported by theory and evidence discussed in the preceding section. This section emphasises the link the between financial development and economic growth, stressing the importance of both financial intermediation and the stock market as sources of financial development based on the arguments discussed in (Levine, 1997,2001).

Supportive evidence that the level of banking sector development has a large causal impact on long-run economic growth comes from firm-level studies (Levine and Zervos, 1998), industry level studies (Rajan and Zingales, 1998) country-level studies (King and Levine, 1993), as well as other studies employing historical time series data (Rousseau and Wachtel, 2011) and different estimation methodologies to accommodate cross-country panel data and endogeneity problems (Levine et al., 2000). As surveyed in Levine (1997, 2001), a large literature has developed assessing the contribution of financial intermediaries to economic growth using various proxies to measure level of development of financial intermediaries or financial markets. For example, early work by King and Levine (1993) apply the ratio of M2 and bank credit to private sector, and find evidence based on cross-country data for 80 countries to support the positive relationship between financial development and economic growth. Subsequently, Levine et al. (2000) conduct their analysis using GMM estimation on a sample of data for 74 countries over the period 1960-1995 and find a positive relationship between financial development and economic growth, after controlling for country-specific differences in institutional or governance variables such as creditor rights, contract enforcement, accounting standards etc. Christopoulos and Tsionas (2004) employ vector autoregression and panel unit root tests to find a positive relationship between financial development and long-term economic growth in nine developing countries. Hassan et al. (2011) analyse the relationship between financial development and economic growth in a sample of lower

[4] The concepts of financial deepening and financial development are very similar, that is to measure the extent of the development of financial system.

and middle income countries using dynamic panel data estimation and confirm that a better developed financial system is necessary for steady economic growth.

While not as extensive as the work on financial intermediation, there is a body of empirical literature suggesting a positive relationship between stock market development and economic growth, coming from both firm level and country level studies (Levine and Zervos, 1996; Arestis et al., 2001; Levine, 2001; Enisan and Olufisayo, 2009). Levine and Zervos (1996), for example, find a strong positive relationship between stock market development and economic growth across countries. Arestis et al. (2001) find similar results in five developed countries but indicate that the contribution of development of the banking sector to economic growth is more powerful than the contribution of the development of stock markets. Enisan and Olufisayo (2009) find that stock market development contributes to economic growth in African countries.

2.3.5.1 The finance-growth nexus: evidence and reverse causality

It is also argued in the literature that financial development results from faster economic growth, implying reverse causality. According to Patrick (1966), who introduced the demand-following and supply-following hypotheses, causality between economic growth and financial development can run both ways. The demand-following hypothesis implies that economic growth precedes the expansion of financial system while the supply-following hypothesis implies that the development of financial sector induces economic growth though more efficient capital allocation. Given these alternative possibilities, it is often argued that causal nature of the relationship between finance and growth may actually depend on the level of economic development. However, the overwhelming evidence from the empirical studies supports the view that finance contributes to economic growth. For example, Calderón and Liu (2003) find that the demand-following hypothesis is strong particularly in the developed countries, although reverse causation also exists.

2.4 Financial liberalisation and financial fragility

Following Diaz-Alejandro (1985), who first argued that financial liberalisation could lead to increased risk of financial crises in developing countries, the relationship

between financial liberalisation and financial crises has received a great deal of attention in the literature. The experience of many developing countries shows that this is indeed the case. For example, Williamson and Mahar (1998) find that of the 34 countries which implemented financial liberalisation policies, all of them experienced some form of systemic financial crises between 1980 and 1997. Hence, it is important to consider the risks associated with financial liberalisation, the sources through which they might occur, relevant supportive evidence and policy implications.

The pioneering study of McKinnon and Pill (1997) takes into account inter-temporal saving and investment decisions in their model, showing that, due to moral hazard and asymmetric information, opening up the capital account with unrestricted capital inflows might lead, in the presence of deposit insurance, to bank lending decision being overly aggressive, thus sending over optimistic signals to firms. Therefore, overborrowing or overinvestment may occur. For example, if the outcome of financial reforms turns out to be less good than expected, the rapid decrease in savings could lead to current account deficit, and firms may have trouble repaying loans which could also put banks into trouble (Arestis and Caner, 2004).

Detragiache and Demirgüç-Kunt (1998) present some theoretical arguments to support their claim that financial liberalisation increases the likelihood of banking crises. They argue that interest rate liberalisation might increase short-term deposit interest rates but banks are not able to raise their lending rates for long-term loans which have fixed interest rates. Therefore, banks might face lower profits since the interest rates on long-term loans cannot be adjusted quickly, and doing so may cause increase in non-performing loans. Thus, the discrepancy between borrowing and lending rates from financial liberalisation could potentially put banks into trouble and increase financial fragility. Additionally, due to adverse selection, relaxing interest rate ceilings and credit allocation increases the possibility of loans to high risk borrowers. Furthermore, due to moral hazard and limited liability of banks, the liberalised financial market may lead to imprudent bank lending.

Dell'Ariccia and Marquez (2006) also examine several channels through which financial liberalisation could lead to increased possibility of financial crisis. Firstly, due to the changing information structure of financial markets, liberalisation attracts more

borrowers whose financial or credit history is unknown and with greater competition in credit markets, banks' incentives to screen and monitor all borrowers is reduced. Thus, increased profits are accompanied by increasing the possibility indiscriminate lending, exposing the banks to greater risk of default. Secondly, increased capital inflows associated with capital account liberalisation lower the costs of bank funds and, consequently, lead to credit boom which tends to increase financial fragility.

2.4.1 Evidence on financial liberalisation and crises

There is a plenty of empirical work linking financial liberalisation with financial fragility, which includes banking crises, currency crises and twin crises linking both.

Detragiache and Demirgüç-Kunt (1998) investigate the relationship between banking crises and financial liberalisation across 53 countries from 1980 to 1995. Using a multivariate logit model and a specially constructed measure of financial liberalisation, their study shows that liberalized financial systems are more inclined to suffer from banking crises in countries where the institutional environment is weak. Mehrez and Kaufmann (2000) examine 56 countries from 1977 to 1997 using a multivariate probit model and indicate that the possibility of banking crises is high especially during the five years after financial reforms. They also find that lack of transparency and government ownership of banks increases the possibility of banking crisis. Shehzad and Haan (2009) also use a multivariate probit model to examine the link between six dimensions of financial reforms proposed by Abiad et al. (2008) and the likelihood of systematic and non-systematic banking crises across 85 countries from 1973 to 2002. They find that the likelihood of non-systemic banking crises increased after financial liberalisation. Angkinand et al. (2010) estimate a multivariable logit model to examine the relationship between banking crises and financial liberalisation in a sample of 48 countries from 1973 to 2005, utilising measures of financial liberalisation proposed by Abiad et al (2008). They find an inverted U-shaped relationship between financial liberalisation and the likelihood of banking crises, implying that the latter occurs more with partial, but not full liberalisation and is mitigated with institutional reforms. Noy (2004) and Menkhoff and Suwanaporn (2007) also find that prudential regulation help to mitigate the possibility of banking crises associated with financial liberalisation.

With regard to evidence based on currency crises, Feridun (2007) analyses episodes of currency crisis in Turkey from the period 1980 to 2006 using signal approach and logit regression and estimates two periods before-post capital account liberalisation, the empirical results show that vulnerability increases with more possibility of currency crises.

Focussing on the link between currency and banking crises, Kaminsky and Reinhart (1999) investigate episodes of 76 currency crises and 26 banking crises in 20 countries over the period 1970 to 1995, and find that financial liberalisation precedes banking crises, with banking crises preceding currency crises which tend to deepen the banking crises. Glick and Hutchison (1999) investigate episodes of 90 banking crises, 202 currency crises, and 37 twin crises in 19 countries over the period 1975 to 1997 and find twin crises episode is most common in liberalised emerging markets and banking crises is a good leading indicator of currency crises.

2.4.2 Evidence on the dual effect of financial liberalisation

From the above discussion, it is clear that financial liberalisation induces financial fragility which therefore implies a cost in terms of lost economic output. Griffith-Jones and Gottschalk (2006), for example, estimate the impact of financial crises on emerging markets output for 8 countries and find that their combined loss of output following a crisis totalled US$1.23 trillion. However, the finance-growth literature discussed above suggests a positive impact of financial liberalisation on economic growth and total factor productivity. This therefore implies a trade-off between the adverse effects (crises and output loss) run and the beneficial effects (economic and TFP growth) of financial liberalisation. Ranciere et al. (2006) decompose the effects of financial liberalisation into economic growth and crises and find that the direct effect of financial liberalisation on growth by far outweighs the indirect effect on crisis. Bonfiglioli (2008) presents similar supportive evidence relating to the impact of financial liberalisation on total factor productivity growth, which remains positive when accounting for currency and banking crises.

Taken together, the evidence seems to suggest that the benefits of financial liberalisation in terms of its positive impact on output or growth outweigh the costs of financial liberalisation associated with financial crises.

2.4.3 Sequencing and policy implications

Given that financial liberalisation has a dual impact on the economy, a question arises as to how liberalisation can be made to work best. A number of studies have addressed this issue by suggesting the importance of sequencing the process of financial liberalisation and advocating the use of a sound regulatory framework with institutional reforms. For example, McKinnon (1993) suggests the following order of sequencing and preconditions: (i) stability of the macroeconomic environment; (ii) institutional precondition such as the necessity to develop a framework of enforceable commercial law before the financial sector is liberalised; (iii) establish effective framework for prudential regulation and supervision; (iv) eliminate interest rate ceiling and credit controls; (v) remove foreign bank entry barriers; and (vi) capital account liberalisation. While sequencing is a controversial policy issue and the subject of an important ongoing debate following the Washington consensus (Williamson, 1990; Rodrik, 2006), it is generally acknowledged that a prudential regulatory and supervision framework backed up by institutional reforms helps to mitigate the adverse effect of financial liberalisation while enhancing the positive impact on growth, as supported by recent research (Detragiache and Demirgüç-Kunt, 1998; io et al., 2001; Tornell et al., 2003; Bekaert et al., 2005).

2.5 Measurement of financial liberalisation

The empirical literature relating financial liberalisation to economic growth and financial fragility has incorporated a variety of measures of financial liberalisation. This section highlights some of the main measures that have been used and illustrates the trends in these measures of financial liberalisation.

Researchers have used a variety of measures to test the impact of financial liberalisation on economic growth. The various measures of financial liberalisation are mainly categorised into *de jure* (rule-based) and *de facto* (outcome-based) measures. The

de jure measures are *ex-ante* constructs from some rule-based method that, for example, highlight the importance of legal, regulatory or institutional power, while the *de facto* measures are constructed from actual practice *ex-post*, such as the extent of capital market liberalisation associated with the degree of capital flows across countries. In earlier research, financial liberalisation was typically measured using a binary (0, 1) dummy (Grilli and Milesi-Ferretti, 1995; Detragiache and Demirgüç-Kunt, 1998; Laeven, 2003). For example, Grilli and Milesi-Ferretti (1995) use a 0/1 dummy to capture the effect of capital controls. Laeven (2003) uses six dummy variables to capture the different dimensions of financial liberalisation. However, the use of dummy variables cannot provide a measure of the magnitude and timing of financial policy changes that occur over time (Abiad et al., 2008). Hence, Abiad et al. (2008) provide a comprehensive database which identifies the multi nature of financial reforms and records financial policy changes along six dimensions (see Table 2-1). However, their database is not sufficiently long to cover the recent crisis period. Focussing on the narrower measure of capital account liberalisation, some authors attempt to construct quantitative measures using the IMF's *Annual Report of Exchange Arrangements and Exchange Restrictions* (AREAER) (Quinn, 1997; Chinn and Ito, 2008; Kose et al., 2009). Table 2.A in the Appendix gives a summary of the various measures of financial liberalisation based on the work of Craigwell et al. (2007). The remainder of this section discusses various indicators of financial liberalisation recently used by researchers in growth and crises related studies.

2.5.1 Measurement issues

With regard to the *de jure* measures, a pioneering work by IMF offers a set of quantitative measures of financial liberalisation based on the use of the *Annual Report of Exchange Arrangements and Exchange Restrictions* (AREAER), which represent the financial restrictions of each country based on its restrictions on exchange payments and its restrictions on exchange receipt. However, Eichengreen (2001) argues that data on "restrictions on payments for capital transaction" may not reflect restrictions on capital transfers by non-residents. Quinn (1997) constructs the intensity of international liberalisation as an index composing of scores reflecting the degree of capital account

liberalisation, current account liberalisation and international agreement from 1950 to 1997. However, this index only reflects the international dimension of financial liberalisation, and excludes domestic aspects of financial liberalisation. Laeven (2003) constructs an index of financial liberalisation that amounts to a sum of six dummy variables reflecting the presence or absence of controls (ranging from 0 to 6) with regard to: (i) interest rate deregulation, (ii) reduction of entry barriers, (iii) reduction of reserve requirements, (iv) reduction of credit controls, (v) privatization of state banks, and (vi) strengthening of prudential regulations. However, this indicator is just a sum of dummy variables (thus not reflecting intensity levels of each dimension) and mainly represents the domestic aspects of financial liberalisation, ignoring capital account liberalisation. Moreover, its coverage is limited to 19 developing countries over the period 1988 to 1998. Abiad et al. (2008) have constructed a comprehensive database of financial liberalisation covering six dimensions reported in Table 2-1 with coverage from the period 1973 to 2005 for 91 countries. The index for each dimension is measured on a scale 0 to 3 based on three survey questions associated with (i) credit controls and high reserve requirements, (iii) interest rate control, (iii) entry barriers, (iv) state ownership of bank sector (privatization), (iv) capital account restrictions (capital account liberalisation), and (vi) securities market policy (equity market liberalisation). The higher score in each category represents the higher level of liberalisation. While comprehensive in various dimensions of financial liberalisation, this database is updated only up to 2005.

Table 2-1 Data Description for each dimension of Abiad el al. (2008)

Source: Abiad el al. (2008)

A recent study by Chinn and Ito (2008) provides a comprehensive measure reflecting the intensity of capital account liberalisation based on the information published in the IMF *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER). They extend their earlier work (Chinn and Ito, 2006) and use binary coding (restriction does not exist =1, otherwise = 0) to calculate the liberalisation index using information relating to four categories (1) the presence of multiple exchange rates; (2) restrictions on current account transactions; (3) restrictions on capital account transactions; (4) the requirement of the surrender of export proceeds. In addition, for the third category of controls on capital transitions, they use the share of a five-year window and incorporate the other three categories. Finally, they transform the binary variables into a quantitative scale, with a higher value of the index implying more liberalisation of the capital account. The advantage of this database is that it has been updated every year and covers a large number of countries, 181 countries, from 1970 to 2011. This indicator has been used by Beine et al. (2010) and Bekaert et al. (2011).

There are, however, some drawbacks of the *de jure* liberalisation index, as Kose et al. (2009) argue that (i) the restrictions on the across board exchange transactions might not necessarily impede the capital flows, and (ii) the index does not effectively reflect the enforcement of capital controls since they can change over time even when the

legal restrictions do not change. With regard to (i), they cite Prasad and Wei (2007) who introduce an example of China, which has strict capital controls yet that has not impeded capital flows into China.

In view of the limitations of *de jure* measures, several *de facto* measures of financial liberalisation have been constructed. There are two broad *de facto* measures: one based on capital flows and the other on the stock of foreign capital assets and liability. Concerning the capital flow measures, Kraay (1998) constructs a measure of the sum of the inward and outward of foreign direct investment, portfolio investment and other investment items in the financial account of the balance of payments, as a percentage of GDP. However, Kose et al. (2009) argue that the flow measure is susceptible to measurement errors and is volatile. With regard to stock measures, Kose et al. (2009) construct a measure of financial liberalisation based on a dataset constructed by Lane and Milesi-Ferretti (2007). This measure is calculated as the ratio of sum of the gross stocks of foreign assets and liabilities to GDP. More specifically, the gross stock of foreign assets is the composition of foreign direct investment assets, portfolio equity assets, debt assets, derivative assets and foreign exchange reserve; the gross stock of foreign liability is the composition of foreign direct investment liabilities, portfolio equity liabilities, debt liabilities and derivatives liabilities. The dataset for this measure is updated to 2007. Kose et al. (2009) argue that the stock measure is more preferable to the flow measure, since it less prone to measurement errors and also less volatile. This indicator has been used by Kose et al. (2009), Levchenko et al. (2009) and Rodrik and Subramanian (2009) . However, Ranciere et al. (2008) argue that the *de facto* measure is influenced by cyclical fluctuations and might not precisely reflect level of financial liberalisation.

As a side issue, it should be noted that some recent studies use an index of economic freedom constructed by the Fraser Institute (Roychoudhury and Lawson, 2010; Barrell et al., 2013). This index includes five components: the size of government, legal structure and security of property rights, access to sound money, trade freedom and regulation credit (Gwartney et al., 2011). This index is therefore much broader in scope than the measures of financial liberalisation appropriate for this study. While the Abiad et al (2008) measure of financial liberalisation is broader in scope reflecting both domestic and international aspects of financial liberalisation, the Chinn and Ito (2008) and Kose et

al (2009) measures are more concentrated on the capital account or the equity market. In the following analysis, we use the Chinn and Ito (2008) *de jure* and Kose et al (2009) *de facto* measures of financial liberalisation to illustrate the trends.

2.5.2 Patterns of Financial Liberalisation

Figure 2-3 compares the trend of the two measures: *de jure* measure (Chinn and Ito 2008) and *de facto* measure (Kose et al., 2009), averaged across all countries[5]. It shows, on average, an increasing trend, with the *de facto* measure increasing more sharply since 1990s. Figure 2-4 to Figure 2-7 compare the average trends in both measures for different income group countries (High, Upper Middle, Lower Middle, and Lower income groups) categorised according to the World Bank classification. High income group countries have experienced relatively higher level of financial liberalisation, with the *de facto* measure rising more steeply. For the upper middle income group of countries, both measures depict a slightly upward but fluctuating trend over the four decades. For the lower middle income group of countries, the trend is very similar but less fluctuating, while for the lower income group countries the de facto measure shows a more steeper upward trend up the mid-1990s. Interestingly, on the *de facto* measure, the upward trend is reversed for a few years in the 1990s, while on the de jure measure the reversal occurs for one year around 1995-6.

[5] These are averaged across all the sample countries that are used in the empirical analysis.

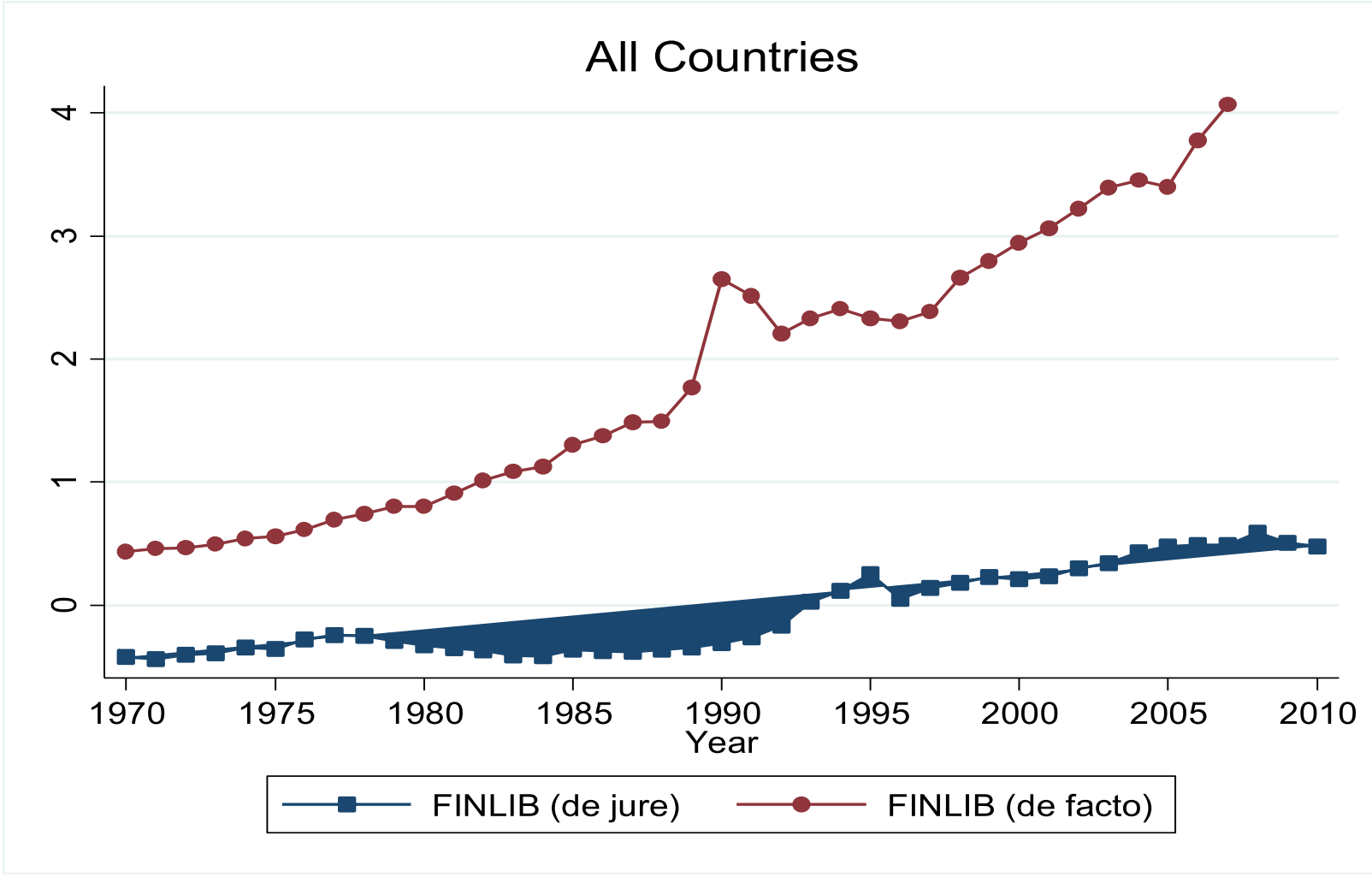

Figure 2-3 Two measures of financial liberalisation (All countries)

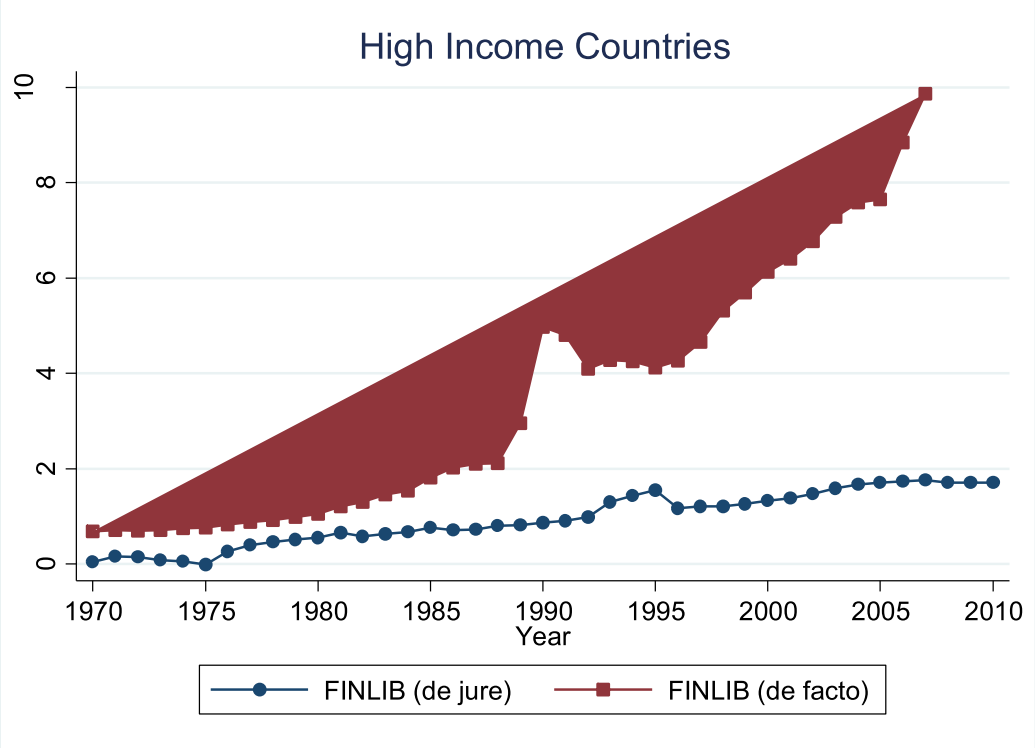

Figure 2-4 Two measures of financial liberalisation (High income)

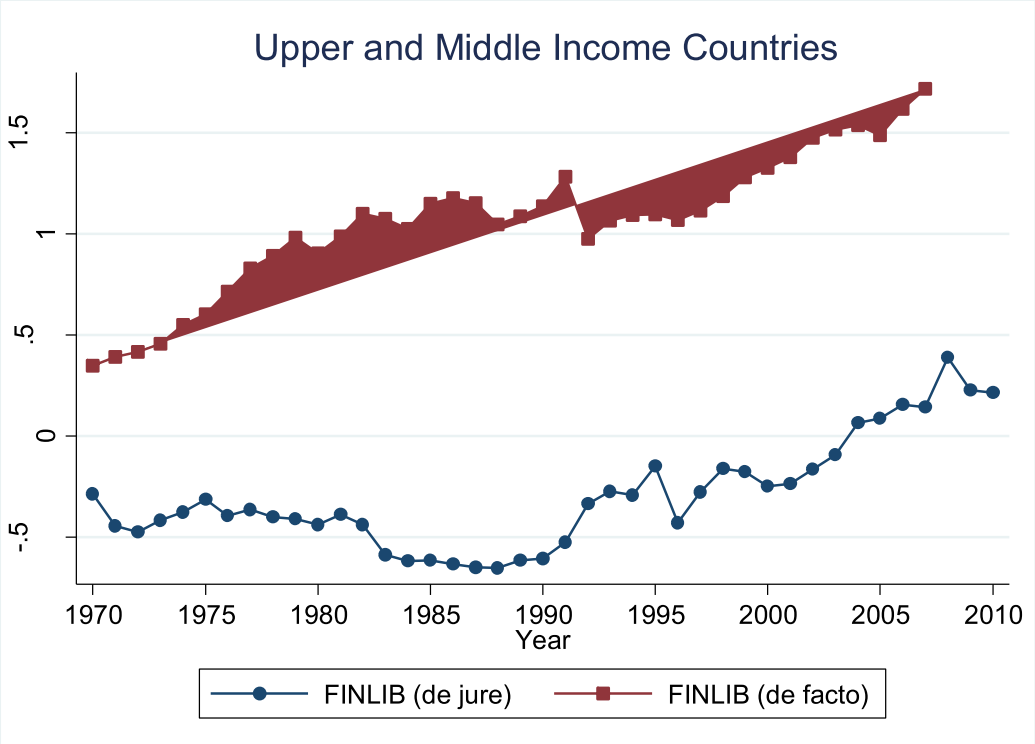

Figure 2-5 Two measures of financial liberalisation (Upper-Middle income)

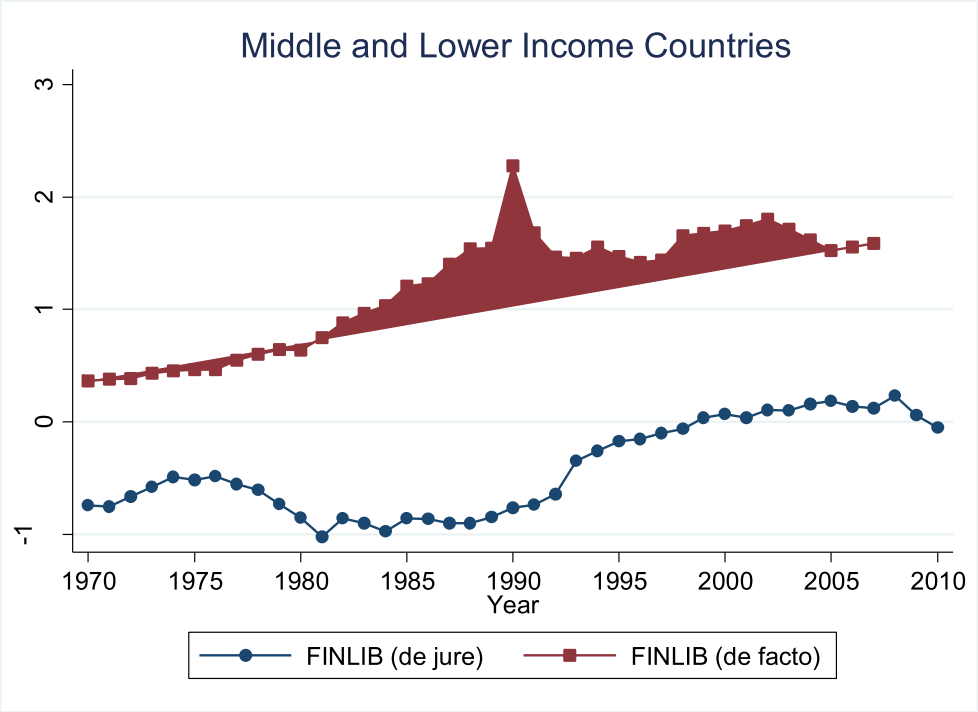

Figure 2-6 Two measures of financial liberalisation (Middle-Lower income)

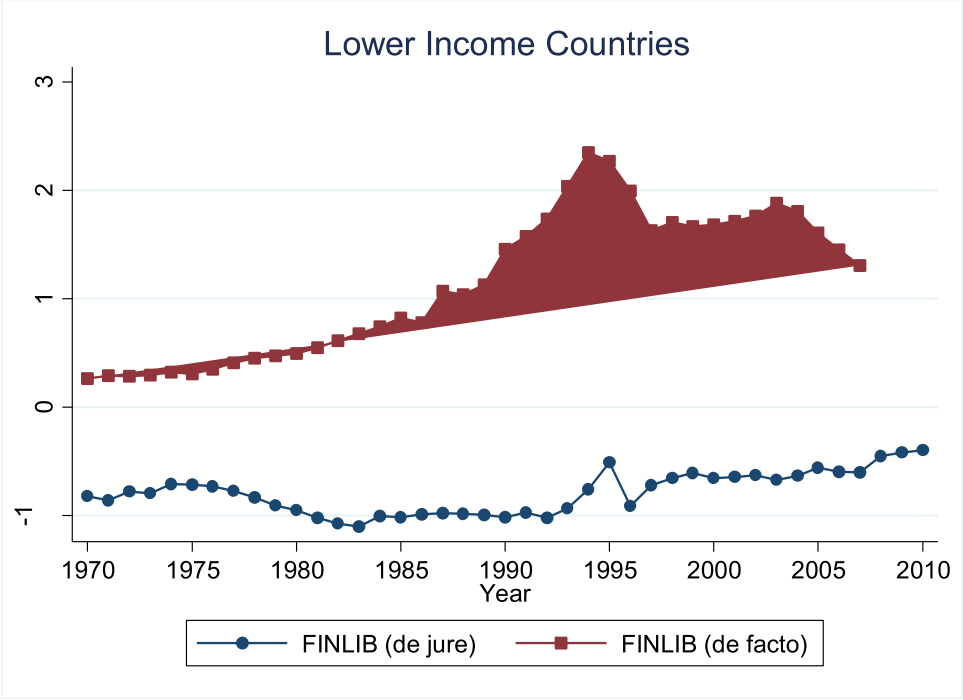

Figure 2-7 Two measures of financial liberalisation (Lower income)

2.6 Conclusion

This chapter has reviewed the historical background and the literature on financial liberalisation as it relates to two main aspects of macroeconomic performance, namely economic growth and financial fragility. This is followed by a discussion of the main measures of financial liberalisation and their evolving trends over the past four decades.

Financial liberalisation policies emerged from the dissatisfaction with financial repression policies practised widely in developing economies in the post-war period up to the early 1970s. These constitute both domestic and international aspects of financial liberalisation, ranging from removal of interest rate ceiling on bank deposits and government control on economic activity to relaxation of entry barriers and capital controls in an attempt to improve financial sector efficiency in the mobilisation of savings and promote economic development. There is now ample evidence to suggest that financial liberalisation contributes to economic growth by increasing both the quantity and quality of investments and improving the functioning of the financial markets. However, experience has shown that financial liberalisation also induces financial fragility and makes the economy more vulnerable to financial crises. On balance, the positive impact of financial liberalisation outweighs the negative impact of financial crises on economic growth and total factor productivity.

With regard to the measurement aspects of financial liberalisation, these have developed from simple crude measures based on the use of dummy variables to more sophisticated measures reflecting the intensity of liberalisation. There are both *de jure* (rule-based) and *de facto* (outcome based) measures of financial liberalisation. Among the *de jure* measures, both Abiad et al. (2008) and Chinn and Ito (2008) have constructed comprehensive indices reflecting different dimensions of liberalisation: the Abiad et al. (2008) measure covers both domestic and international aspects while the Chinn and Ito (2008) measure reflects the intensity of capital account liberalisation; With regard to the *de facto* measure, Kose et al. (2009) constructs their measure based on stock of foreign assets and liability over GDP. Generally, there is no consensus in the literature as to which measurement of financial liberalisation is better.

In terms of the evolving patterns of financial liberalisation across countries, both measures indicate an upward trend over the past four decades which is more pronounced

in higher and lower income countries, especially on the *de facto* measure, compared to middle income countries where is trend is more fluctuated. Generally, the *de jure* index is less fluctuated than the *de facto* measure, although on both measure there is slight reversal of the upward trend in the 1990s.

Appendix 2.A

Summary of the Various Measures of Financial Liberalisation in the Literature

Authors	Description of financial liberalisation measure	Period
IMF's AREAER [*de jure*]	Generates a 0-1 indicator (0 means always restricted, 1 means never restricted) of the existence of rules or restrictions that inhibit cross-border capital flows or discriminate on the basis of citizenship or residence of transacting agents.	1967-1995
Grilli and Milesi-Ferretti (1995) [*de jure*]	**Share indicator**: uses the summary line of IMF's AREAER to measure the proportion of years the country's capital account is reported as free of restrictions. The resulting variable is a 0/1 indicator of the presence or absence of capital controls.	1966-1989
Quinn, (1997) [*de jure*]	**International liberalisation index**: Measures the extent of a country's restrictions on the flow of international finance using the detailed text of the IMF's AREAER. Capital account openness is scored on a graduating 0-4 scale, current account openness on a 0-8 scale, and international agreements on a 0-2 scale, where the large number represents more liberalised. The resulting 0-14 range indicator is an overall measure of the intensity liberalisation.	1950-1997
Detragiache and Demirgüç-Kunt (1998) [*de jure*]	**Domestic financial liberalisation**: Use the first date in which some interest rates were liberalised create a dummy variable with 0 for periods in which interest rates are subject to controls and 1 for the liberalised periods	1980-1995
Kraay (1998) [*de facto*]	**Capital account openness**: uses data on actual capital inflow and outflow the sum of the inward and outward foreign direct investment, portfolio investment and other investment items in the financial account of the balance of payments as a percentage of GDP.	1985-1997
Montiel and Reinhart (1999) [*de jure*]	**Capital account liberalisation intensity index**: combines the IMF's AREAER indicator with country specific information (annual reports of country's central bank) to construct an index capturing the intensity of capital controls.	1990-1996
Bekaert and Harvey (2000) Update by Bekaert et al. (2005) [*de jure*]	**Equity market liberalisation indicators**: three 0-1 dummy variables: *Official Equity Market Liberalisation index*, which reflects chronologically any regulatory change after which investors officially have the opportunity to invest in the domestic equity market. The variable takes the value of one when the event makes it possible for foreign portfolio investors to own the equity of the particular market and zero otherwise. *Break points in capital flows* estimated through a regime switching model based on the time series of net U.S. capital flows. *First Sign*: the earliest of three possibilities: a launching of a country fund, an American Depositary Receipt (ADR) or announcement of official Liberalisation.	1980-1997
Bandiera et al. (2000) [*de jure*]	**Financial liberalisation index**: the combination (principal component analysis) of 8 dummy variables representing the various dimensions of liberalisation: *Domestic financial liberalisation*: interest rates, pro-competition measures, reserve requirements, directed credit, banks' ownership, prudential regulation. *International financial liberalisation*: capital account and exchange rate liberalisation.	1970-1994
Edison and Warnock (2003) [*de facto*]	**Capital account Liberalisation Intensity Index**: 1 minus the ratio of the market capitalisation of the constituent firms comprising the IFC Investable index to those that comprise the IFC Global index for	1989-1997

	each country. The IFC Global index is designed to represent the overall market portfolio for each country, whereas the IFC Investable index represents the portion of domestic equities that are available to foreign investors. A ratio of 1 indicates that all of the stocks are available to foreign investors.	
Kaminsky and Schmukler (2003) [*de jure*]	**Financial liberalisation index** (average of the two indices): *Domestic financial liberalisation*: focus on interest rate regulations and complement with information on the regulations reserve requirements, credit allocation and foreign currency deposits. *Capital account liberalisation*: regulations on offshore borrowing by domestic financial institutions, offshore borrowing by non-financial corporations, multiple exchange rate markets, and controls on capital outflows.	1973-1999
Laeven (2003) [*de jure*]	**Financial liberalisation indicator** (the sum of six dummy variables): interest rate deregulation, reduction of entry barriers, reduction of reserve requirements and reduction of credit controls, privatization of state banks and strengthening of prudential regulation.	1989-1998
Abiad and Mody (2005) [*de jure*]	**Financial liberalisation index** (aggregation of six dimensions): directed credit/reserve requirements; interest rate controls; entry barriers and/or lack of pro-competition policies; restrictive operational regulations; the degree of privatisation in the financial sector; and controls on international financial transactions. For each dimension, a country is given a score on a graded scale, with zero corresponding to being fully repressed, 1 to partially repressed, 2 to largely liberalised, and 3 to fully liberalised.	1973-1996
Abiad et al. (2008) [*de jure*]	**Financial liberalisation index**: six dimensions (each dimension is measured by 0 to 3 from three questions; the description of each dimension is reported in Table 2 1) of financial liberalisation from the period 1973 to 2005 for 91 countries: credit control and excessively high reserve requirements, interest rate control, entry barriers, state ownership of bank sector (privatization), capital account restriction (capital account liberalisation), securities market policy (equity market liberalisation).	1973-2005
Chinn and Ito (2008) [*de jure*]	**Capital account liberalisation:** base on IMF's AREAER use binary code to calculate the liberalisation index based on the information of four categories of restrictions (restriction does not existed =1, otherwise = 0): (1) the presence of multiple exchange rates; (2) restrictions on current account transactions; (3) restrictions on capital account transactions; (4) the requirement of the surrender of export proceeds. The third categories of the controls on capital transitions, they use the share of a five-year window and incorporate other three variables.	1970-2011
Kose et al. (2009) [*de facto*]	**Financial liberalisation index**: the ratio of sum of the gross stocks of foreign assets and liability to GDP. The gross stock of foreign assets is the composition of foreign direct investment assets, portfolio equity assets, debt assets, derivative assets and foreign exchange reserve; the gross stock of foreign liability is the composition of foreign direct investment liabilities, portfolio equity liabilities, debt liabilities and derivatives liabilities.	1970-2007

Note: The table is based on the work of Craigwell et al. (2007) to illustrate various measurements of financial liberalisation were used in previous studies.

Appendix 2.B

Summary of the empirical evidence on financial liberalisation and TFP growth link

Paper	Main Research Design	Measure of Finlib	Main Findings
Bonfiglioli (2008)	The impact of financial liberalization on aggregate TFP growth and capital accumulation in a sample of 70 developing and industrialized countries (1975-1999). Method: system GMM.	Two *de jure* and one *de facto* measures of financial liberalisation	Especially for developing countries the positive impact of financial liberalisation on TFP growth, but only weak for capital accumulation is observed.
Kose et al. (2009)	The impact of financial openness on productivity growth, rather than output growth from 1966 to 2005 with industrial and Non-industrial countries. Method: Dynamic panel regression.	Chinn and Ito (2008) *de jure* measure; Bekaert and Harvey, (2000) measure of equity market openness; and Lane and Milesi-Ferretti (2007) *de factor* measure.	*De jure* capital account openness has a robust positive effect on TFP growth. The effect of *de facto* financial integration on TFP growth is less clear.
Alfaro et al. (2009)	The influence of FDI on factor accumulation and TFP growth for 62-72 countries between 1975-1995 Method: cross-section OLS	Net FDI inflows from IFS database.	TFP growth due to FDI is positive especially for countries with well-developed financial markets.
Bekaert et al. (2011)	The impact of financial openness on factor productivity and capital accumulation for 96 countries over the period 1980-2006. Method: Pooled OLS with cross-sectional correction of standard errors.	Capital market openness from IMF's AREAER; Bekaert and Harvey (2005) measure of equity market openness; Bekaert (1995) and Edison and Warnock (2003) measure of equity market openness.	Growth effects of financial liberalisation are permanent due to the impact of factor productivity. To a lesser extent, also investment channel is effective.
Gehringer (2013)	How does financial integration influence the TFP growth? Sample: 26 EU members (1990 - 2007). Method: difference GMM.	Chinn & Ito (2008) *de jure* measure; Lane and Milesi-Feretti (2007) *de facto* measure.	EU integration has a positive impact on productivity growth.

Note: The table is based on the work of Gehringer (2013) to illustrate various measurements of financial liberalisation were used in previous studies.

Appendix 2.C

Summary of the empirical evidence on financial liberalisation and financial fragility link

Paper	Main Research Design	Measure of Finlib	Main Findings
Detragiache and Demirgüç-Kunt (1998)	Empirical relationship between banking crises and financial liberalisation in a panel of 53 countries for the period 1980–95. Method: A Multivariate Logit Model.	One *de jure* (dummy) measure of financial liberalisation	Banking crises are more likely to occurring liberalised financial systems. However, the effect of financial liberalisation on the fragility of the banking sector is weaker when the institutional environment is strong.
Glick and Hutchison (1999)	Investigating whether legal restrictions on international capital flows are associated with greater currency stability for 69 developing economies over the 1975–1997 period, identifying, and 160 currency crises. Method: probit model.	IMF's *de jure* measure of financial liberalisation	Restrictions on capital flows do not effectively insulate economies from currency problems; rather, countries with less restrictive capital controls and more liberalised regimes appear to be less prone to speculative attacks.
Kaminsky and Reinhart (1999)	The causes of banking and balance-of-payments problems by investigating 76 currency crises and 26 banking crises from 1970 to 1995 including 20 countries. Method: The Interval Between Signals and Crisis: Defining a Reasonable Period of Time.	M2 multiplier, the ratio of domestic credit to nominal GDP, the real interest rate on deposits, and the ratio of lending-to-deposit interest rates	Problems in the banking sector typically precede a currency crisis—the currency crisis deepens the banking crisis, activating a vicious spiral; financial liberalisation often precedes banking crises.
Mehrez and Kaufmann (2000)	Investigating the effect of financial liberalisation on the probability of banking crises in economies with poor transparency using data on 56 countries from 1977 to 1997. Method: A Multivariate Logit Model.	One *de jure* (dummy) measure of financial liberalisation from survey of Williamson and Mahar (1998)	Financial liberalisation increases the probability of a crisis during the five years following liberalisation. The probability of a crisis following liberalisation is higher in countries with poor transparency than in countries that are transparent.
Feridun (2007)	Identifying the determinants of currency crises in Turkey in the period of 1980:01-2006:06. Method: Signals approach and bivariate and Multivariate logit regressions.	Pre and post financial liberalisation period	Financial liberalisation has rendered the Turkish economy vulnerable to currency crises
Shehzad and Haan (2009)	Examining the impact of various dimensions of financial reform on the likelihood of systemic and non-systemic banking crises. Using new financial reform measures for a large sample of developing	Abiad et al . (2008) financial liberalisation index: six dimensions	They find conditional on adequate banking supervision, certain dimensions of financial reform reduce the likelihood of systemic crises, but the likelihood of non-systemic crisis increases after

	and developed countries for the period 1973 to 2002. Method: Multivariate probit model.		financial reform.
Angkinand et al. (2010)	The impact of financial liberalisation on banking crises in 48 countries between 1973 and 2005. Method: Multivariate Logit Model.	Abiad et al . (2008) financial liberalisation index: six dimensions	An inverted U-shaped relationship between liberalisation and the likelihood of crisis. The most important type of liberalisation in relation to banking crises seems to be behavioural (a relaxation of interest and credit controls).

CHAPTER 3

FINANCIAL LIBERALISATION AND THE BANKING SECTOR

3.1 Introduction

While the previous chapter focussed on aspects of financial liberalisation relating to the wider economy, this chapter concentrates on its impact on bank behaviour, which includes a review of the literature on banking risk taking, efficiency and productivity, as it concerns financial liberalisation. As noted in Chapter 1, the behaviour of the banking sector is influenced by financial liberalisation through the conduct of financial markets. The deregulation of the financial sector generally increases the risk taking initiatives of banks which face greater competition and so might force them to improve their efficiency by reducing their costs and increasing their revenue, or enhance their productivity by employing advanced technology and management skills. The literature on bank efficiency and productivity is quite broad analysing various causal determinants including risk, competition and deregulation of the industry, with most of the studies focussing on individual countries or specific regions. There are, however, a limited number of cross-country studies focussing on specific aspects of financial liberalisation or deregulation, such as the impact of foreign ownership on bank efficiency (Lensink et al., 2008), the impact of FDI on bank total factor productivity growth (Tanna, 2009) and the impact of regulations on bank efficiency (Pasiouras, 2008; Pasiouras et al., 2009).

This chapter provides a review of the literature on bank risk taking, efficiency and productivity before discussing studies linking with financial liberalisation. The traditional literature has focussed on the impact of deregulation of the banking industry associated with branch expansion and mergers and acquisitions. The results are generally mixed (Berger and Humphrey, 1997). In providing a comprehensive review of the impact of financial liberalisation on the banking sector, addressing its impact on banking risk, efficiency and productivity, this chapter is structured as follows: Section 3.2 reviews the

literature on bank risk taking; Section 3.3 on bank efficiency; Section 3.4 on bank productivity; and Section 3.5 is conclusion.

3.2 Bank risk taking

Though there is little consensus about the main sources or determinants of bank risk taking, various studies examine the relationship between deposit insurance and risk taking, regulation and risk raking, and competition and risk taking through various channels such as charter value, market discipline, and ownership structure that may affect the bank risk taking behaviour.

3.2.1 Regulation and risk taking

There is some empirical evidence on the relationship between regulation and bank risk-taking showing that regulation can either increase or decrease bank risk depending on the charter value, ownership and degree of market power associated with banks. González (2005) estimates the impact of regulation on risking across banks in 36 countries and finds that stricter regulation induces banks' risk-taking behaviour by decreasing the charter value of banks. However, Laeven and Levine (2009) find that regulations improve loan diversification and reduce bank risk. Agoraki et al. (2011) show that banks with more market power weaken the effect of capital requirements on reducing the risk, while higher activity restrictions in combination with more market power reduce both credit and default risk of banks.

3.2.2 Competition and risk taking

The theoretical literature on the relationship between competition and risk taking traditionally relates to the "franchise value" or "charter value" paradigm, which plays an important role in either increasing or limiting bank risk-taking. Generally speaking, banks limit their risk-taking in order to protect the quasi-monopoly rents granted by their government charters. Increased competition would erode these rents and the value of the charters, which induce banks to take greater risk and create more likelihood of financial instability. However, the traditional "franchise value" paradigm has recently been challenged by "competition and stability" hypothesis that argues that if banks offer lower

interest rates to borrowers and diminish their incentives to shift into riskier projects, greater competition may reduce bank risk (Boyd and De Nicolo, 2005).

There is plenty of empirical literature on the relationship between competition and risk which highlight the "franchise value" paradigm, many of them at individual country level (Keeley, 1990; Demsetz et al., 1996; Salas and Saurina, 2003; Bofondi and Gobbi, 2004; Jiménez et al., 2010). Keeley (1990) and Demsetz et al. (1996) study US banks, Salas and Saurina (2003) and Jiménez et al. (2010) study Spanish banks, while Bofondi and Gobbi (2004) consider banks in Italy. There are also several studies at cross country level. Boyd and De Nicolo (2005), using a sample of banks for 134 countries, find that greater competition induces higher default risk of banks. However, Beck et al. (2006) investigate banks in 69 countries and find that more concentration (of national banks measured by the share of assets of three largest banks) lowers the likelihood of banking crises. Yeyati and Micco (2007) find that greater competition increases bank risk in Latin America countries. Overall, the empirical evidence seems to support the consensus that greater competition increases the risk taking incentives of banks.

3.2.3 Financial liberalisation and risk-taking

Financial liberalisation may increase the competition in the financial market that erodes banks' charter value. Apart from the competition channel, financial liberalisation may raise interest rate further which increases the costs of banks' funds and lower their profits. In turn, banks may be inclined to take greater risk with assets for higher revenue to compensate for the lower profits (Humphrey and Pulley, 1997). Additionally, financial liberalisation also provides more opportunities for banks to take greater risk through non-traditional activities. There is a body of empirical literature which directly investigate the relationship financial liberalisation on risk-taking. For example, Mishkin (2001) finds that financial liberalisation increases the possibility of banks to participate in high risk investment projects and create a moral hazard problem. Hellmann et al. (2000) suggest that financial liberalisation induces more competition in the financial market, which erodes profitability and decreases bank charter value, so banks might seek risker portfolios that increase bank instability. They find a negative relationship between financial liberalisation and prudential behaviour in the banking sector. Ranciere et al.

(2006) suggest that financial liberalisation increases the credit risk of banks, resulting in credit booms might contribute to short-term high economic growth but also lead to potential instability of the financial system. Cubillas and González (2013) directly investigate the relationship between financial liberalisation and risk as measured by default risk of banks in 83 countries, and find financial liberalisation increases the default risk in both developed and developing countries. The empirical results seem to support the view that financial liberalisation increases risk-taking behaviour in the banking system that might be harmful for long-term economic growth and financial stability.

3.2.4 Deposit insurance and risk taking

There are various studies which suggest that deposit insurance make depositors less inclined to monitor banks, therefore giving banks an incentive to take on greater risk. Some papers have looked at individual country evidence and find a positive relationship between deposit insurance and risk taking (Ioannidou and Penas, 2010; DeLong and Saunders, 2011). Ioannidou and Penas (2010) study Bolivian banks, while DeLong and Saunders (2011) study US banks. With regard to cross-country studies, empirical studies generally investigate the possibility of bank instability or crises at the aggregate level, rather than bank risk taking, and show that deposit insurance causes a moral hazard problem in lending behaviour which increases the probability of banking crises (Demirguc-Kunt and Kane, 2002; Demirgüç-Kunt and Huizinga, 2004). However, empirical evidence also shows that the adverse impact of deposit insurance on risk taking depends on the contract environment and on the level of freedom in bank activity. Cull et al. (2005), Demirgüç-Kunt and Detragiache (2002), Demirguc-Kunt and Kane (2002), and Laeven (2002) find that the adverse impact of deposit insurance on bank risk-taking is mitigated by a sound legal system. Hovakimian and Kane (2000) indicate that prudential regulations such as restrictions on bank activity work as an efficient tool for reducing banks risk taking rather than as a block for diversification. In general, the empirical evidence shows that deposit insurance has an adverse impact on risk taking, but in countries with a sound legal system or regulation this effect might be weakened.

3.3 Bank efficiency

There is a large body of empirical studies that examine the impact of policies and market influences, such as regulation, financial liberalisation, competition and risk, on bank efficiency. Hughes and Mester (2008) indicate that the determinants of bank efficiency depend on specific and envionmental factors on banks, such as the legal, regulation, supervision, and contracting environments they operate in. More specifically, bank ownership, size, capital structure and asset quality, as well as regulations, account practice, merger and acquisitions, and other internal and external polices influence bank efficiency. For example, Harker and Zenios (2000) indicate that the degree to which bank industry is regulated in particular countries influences their efficiency. Efficiency is further impacted by financial market deregulation, which reshapes the banking sector by changing banks' ownership and capital structure, as well as by new technological development, which improves the quality of financial services and reduces the costs of transactions.

3.3.1 Regulation and bank efficiency

Barth et al. (2013) conclude two mechanisms of impact for the regulation of bank efficiency: "public interest view" and "private interest view". The "public interest view" refers to government acts in the interests of the public, and regulates banks to promote efficient banking to ameliorate market failures. In contrast, the ''private interest view'' refers to the regulation that is often used to promote the special interests of the few, not the broader public, thus impeding bank efficiency.

Recent literature examines the relationship between regulation and bank efficiency, mainly at a cross-country level. Pasiouras (2008) studied the impact of regulation on the technical efficiency of banks in 95 countries and found that market discipline has a significant impact on technical efficiency. Pasiouras et al. (2009) examined the impact of regulations relating to the three pillars of Basel II in 63 countries, and found how supervision greatly improves both cost and profit efficiency. They also found a positive impact of capital requirement on cost efficiency, but a negative impact on the profit efficiency, and while the effects of restrictions on bank activity improves profit efficiency, at the same time it impedes cost efficiency. Other similar research

includes Chortareas et al. (2012), who studied banks in European Union countries, and Barth et al. (2013), studying banks across 73 countries. Additionally, Gaganis and Pasiouras (2013) have further invesigated the impact of financial supervison regimes on bank efficiency and have found that the greater the number of financial sectors that are supervised by the central bank, the less efficient they are.

3.3.2 Competition and bank efficiency

The theoretical literature on the relationship between competition and efficiency are generally divided into two camps. The "quiet life" hypothesis highlights that increased competition enhances cost efficiency, since monopoly power gives managers monopoly rents, which often leads some of them towards forms of discretionary expenses or slack. Hicks (1935) indicates that monopoly power allows managers to relax their effort and live a "quiet life", and therefore increased concentration leads to decreased efficiency. Leibenstein (1966) suggests that competition reduces the inefficiency, because managers have more incentive to act. On the other hand, the "efficient structure" hypothesis (Demsetz, 1973), who argues that cost efficiency reduces competition (a reserve causal relationship between competition and efficiency). The more efficient firms have lower costs, and consequently higher profits and the larger market share.

There is a body of empirical studies on the relationship between competition and efficiency mainly for the EU banking sector. Weill (2004) investigates the relationship between the competition (using Rosse-Panzar model H-statistic) and cost efficiency of the EU banking sector, and finds a negative relationship between competition and cost efficiency. Fernandez de Guevara et al. (2005) uses Lerner indicator as a proxy for market power of the EU banking sector and supports the negative relationship between competition and efficiency. Casu and Girardone (2009) employ Granger's causality GMM dynamic panel estimators method and find limited evidence to support increased that market power (Lerner indicator) translates to lower cost efficiency in main EU banks. Schaeck and Cihak (2008) find that competition improves bank efficiency in EU and US banks. Delis and Tsionas (2009) employ a local maximum likelihood (LML) technique to drive bank-specific market power for US and EU banks, and find a negative relationship between market power and efficiency. Turk Ariss (2010) finds that a greater degree of

market power enhances profit efficiency but that there is a significant loss of cost efficiency in developing countries. Williams (2012), in researching the market power and efficiency in Latin America banking, has discovered that the empirical results reject the "quiet life" hypothesis, while supporting the "efficient structure" hypothesis.

3.3.3 Financial liberalisation and bank efficiency

The empirical studies about the relationship between financial liberalisation and bank efficiency are limited, and most of them are at individual country level. One of the exceptions is Hermes and Nhung (2010), who analyse the impact of financial liberalisation on overall technical efficiency, pure technical efficiency and scale efficiency in the Latin America region from the period of 1991 to 2000. They use DEA (data envelopment approach) to measure the efficiency of banks, and then a panel least square fixed-effect model to analyse the impact of financial liberalisation on bank efficiency. Their results strongly support that financial liberalisation improves the efficiency of banks.

Other studies are mainly individual country-level analyses, investigating the period before and after financial reforms. Williams and Intarachote (2002) investigate the impact of financial liberalisation on profit efficiency in the Thai banks and find that the profit efficiency of banks decreases during the deregulation period. Denizer et al. (2007) find that the efficiency of Turkish banks declined after financial liberalisation. Bonaccorsi di Patti and Hardy (2005) estimate the influence of financial liberalisation on bank costs and profit efficiency, and find bank profit efficiency improved immediately following the liberalisation, while the efficiency improvement does not continue in subsequent years. Chen et al. (2005) investigate the financial deregulation of China in 1995 and found the cost efficiency of banks had improved. Kumar and Gulati (2010) indicate financial deregulation positively impacts on the cost efficiency of India's public sector banking industry.

On the other hand, financial liberalisation includes various dimensions such as entry barrier liberalisation, interest rate liberalisation, privatization etc. The following section illustrates the impact of various dimensions on bank efficiency.

3.3.3.1 Entry barrier liberalisation and bank efficiency

Eliminating the entry barrier may lead to a geographic expansion in bank industry through direct entry into the domestic market or merger and acquisition scenarios that increase the competition in the domestic financial market, ultimately influencing the efficiency of bank operations. Hermes and Lensink (2008) indicate that financial liberalisation leads to more competition, which forces banks to improve their operation strategy, typically through improving bank management and service quality in order to reduce the overhead operation costs and become more efficient. However, Berger and Humphrey (1991) indicate that financial liberalisation leads to a wave of bank merger and acquisitions for the short-term, rather than eliminating excessive branch-banks that lead to overcapacity, increased costs and induced inefficiency. Casu and Girardone (2009) find that competition accelerates consolidation and increases concentration in the banking sector. According to the "quiet life" hypothesis (Hicks, 1935), managers do not need to control the costs, hence lowering the bank cost efficiency (Berger and Hannan, 1998). Therefore, the debate for whether entry barrier liberalisation improves bank efficiency is still an open question.

3.3.3.2 Interest rate liberalisation and bank efficiency

Removing the interest rate ceiling causes the deposit interest rate to go up, which in turn leads to increased liability costs for banks because they should pay more to the depositors. Humphrey and Pulley (1997) found that interest rate deregulation increased the funding costs and lowered the profits for US banks in the early 1980s. Hence, as noted above the interest rate liberalisation may have a negative impact on bank efficiency.

3.3.3.3 Privatization and bank efficiency

There is a body of literature investigating the relationship between privatization and bank efficiency, which finds that foreign-owned banks are more efficient than state-owned domestic banks (Bonaccorsi di Patti and Hardy, 2005; Matthews and Ismail, 2006; Sensarma, 2006). These studies tend to be on an individual country level: Bonaccorsi di Patti and Hardy (2005) study banks in Pakistan; Sensarma (2006) studies banks in India;

Matthews and Ismail (2006) study banks in Malaysia; Berger et al. (2009) study banks in China. With regard to regional or cross-country studies, Bonin et al. (2005) analyse the impact of privatization on bank efficiency in transition economies and find government-owned banks are less efficient than foreign-owned banks. Semih Yildirim and Philippatos (2007) analyse the profit and cost efficiency in transition economies and find that foreign-owned banks are more cost efficient, but less profit efficient than state-owned banks. Therefore, most of the previous empirical evidence seems to suggest that foreign-owned banks are more efficient than state-owned banks, implying that privatization might improve bank efficiency.

3.3.4 Risk and efficiency

A body of literature analyses the possible relationship between efficiency and risk in the banking sector. Berger and DeYoung (1997) find bad loans as a proxy of risk for banks negatively influences cost efficiency among bankrupt banks. Kwan and Eisenbeis (1997) find the negative relationship between risk-taking behaviour and efficiency among financial institutions. However, Hughes and Mester (1993) suggest that risk-averse managers are more likely to lend higher quality loans, but the costs might be increased for monitoring of loan performance, hence lowering cost efficiency. Williams (2004) analysed the inter-temporal relationship between problem loans and cost efficiency from 1990 to 1998 for EU saving banks and found that poorly managed banks are more likely to have lower quality loans that increased costs. Hughes and Mester (2008) studied the efficiency, risk and asset quality in the banking sector and suggested that the quality of equity capital influences the insolvency risk of banks. Altunbas et al. (2007) investigated banks in European countries from 1992 to 2000 and failed to find a strong relationship between bank inefficiency and risk-taking behaviour. Fiordelisi et al. (2011), investigate the inter-temporal correlation between efficiency and risk taking for European banking and conclude that less efficient banks have more incentive to take risks.

3.3.5 Other studies on bank efficiency

There are a number of studies on bank efficiency that are not directly related to financial liberalisation: they investigate bank specifics, such as bank size, their environment, and market factors that might influence their efficiency.

3.3.5.1 Studies on scale and scope economies

Early empirical studies about bank efficiency are more concerned with the estimation of scale and scope of efficiency. These studies discuss one main question: whether banks increase outputs, such as whether expansion of size decreases the average costs. Most of the empirical results indicate that economies of scale exist for small banks (total assets are less than 100 million dollars), and diseconomies of scale exist for larger banks. However, previous literatures found little evidence to support the existence of scope economies among banks. Alhadeff (1954) investigated the costs of California branches banks from 1938 to 1950 and found smaller and larger sized banks have scale economies, and middle size banks have a constant return for scale. However, Schweiger and McGee (1961) argued that Alhadeff (1954), using earning assets as a proxy outputs for banks that exclude other assets, was likely to overstate the average costs of large size banks and lead to some bias for empirical results. They employed total assets as a proxy for banks output and find the economies of scale for all size banks. Greenbaum (1967) developed the weighted output index approach and found a U-shape relationship between average costs and bank size. A similar finding was reached by Kalish Iii and Gilbert (1973) and Benston et al. (1982). Later, in the 1990s, some of the studies found that the scale of bank economies is result of improvement of technology. Hunter and Timme (1991) estimated the influence of technological change on scale efficiency for large commercial banks in the United States from 1980 to 1986. They found that improvement in technology contributes a reduction of 1.0% of the costs per year of banks and that there are no considerable diseconomies among large banks. Clark and Speaker (1994) found substantial scale economies for banks with a size of $1 billion of total assets. Therefore, the previous empirical evidence seems to suggest that there is generally a U-shaped relationship between average costs and size; small banks are more likely to have scale economies and there is little evidence of significant economies of scale for banks.

3.3.5.2 Other studies on bank efficiency

Concerning single countries' studies on bank efficiency, Ferrier and Lovell (1990) employed a frontier method and a linear programming method to estimate the cost efficiency of 575 U.S. financial institutions, and find banks present a higher inefficiency when using the linear programming method. Berger and DeYoung (1997), employing Granger-causality techniques to investigate cost efficiency, loan quality and bank capital of U.S. banks from 1985 to 1994, found that loan quality and cost efficiency run in both directions. Subsequently, some efficiency studies focus on European and Asian countries: Hasan and Lozano–Vivas (2002) estimated cost efficiency for 480 commercial and 490 saving banks in Spanish from 1986 to 1995 and find commercial banks are more efficient than saving banks. Kwan (2006) investigated cost efficiency of Hong Kong commercial banks from 1992 to 1999 using stochastic frontier methods and found on average that small banks are more efficient than larger banks. However, their study did not attempt to control the environment factors that might influence bank efficiency. In turn, Drake et al. (2006) estimated technical efficiency of banks in Hong Kong and found that environmental and market factors have a large impact on bank efficiency.

With regard to cross-country studies, Berger and Humphrey (1997) surveyed 130 efficiency studies across 21 countries using various frontier efficiency methods and concluded that the average cost efficiency score was about 80% (20% cost inefficiency). They suggest the efficiency scores measured by parametric and nonparametric approaches are similar, but the efficiency scores measured by nonparametric approach are more dispersion. Pastor et al. (1997) compared the cross-county efficiency of banks in eight developed countries (seven European countries and the United States) and found the average efficiency score was 86%, whereas the lowest was the UK banks at 55% and the highest was the French banks at 95%.

3.4 Bank Productivity

In contrast to the literature on bank efficiency, studies on bank productivity growth are relatively few, comprising mainly individual country studies but also some cross-country studies. Mainly, these investigate the sources of productivity (TFP) growth in response to financial liberalisation or deregulation (Berg et al., 1992; Grifell-Tatje and

Lovell, 1996; Worthington, 1999; Mukherjee et al., 2001; Dogan and Fausten, 2003; Isik and Hassan, 2003; Tirtiroglu et al., 2005; Tanna, 2009; Delis et al., 2011).

3.4.1 Regulations and Productivity

The most recent study by Delis et al. (2011), which examine the relationship between financial regulation and productivity of banks for 29 countries in the transition economies of Central and Eastern Europe over the period 1999 to 2009, find that regulations relating to private monitoring and restrictions on bank activity affect bank productivity, and suggest that policy makers should ensure transparency or disclosure of information to provide encouragement for private monitoring and market discipline.

3.4.2 Financial deregulation and productivity

There is a body of literature empirical literature relating financial deregulation to bank productivity; mainly these are country-level studies. The early study by Berg et al. (1992), which used the Malmquist index of productivity growth for Norwegian banks from 1980 to 1989, found that productivity declined before but grew rapidly after financial deregulation. Grifell-Tatje and Lovell (1996) study saving banks in Spanish and find that productivity declined the period of deregulation. Wheelock and Wilson (1999) estimate the Malmquist index of productivity change for US banks from 1983 to 1994 and find that average productivity declined during that period due to the improvement of the technological frontier. However, Alam (2001) finds that productivity of US commercial banks rose from 1983 to 1984, decreased in 1985 and grew afterwards. Dogan and Fausten (2003) study productivity of banks in Malaysia and find that financial liberalisation is not sufficient to support productivity growth. Isik and Hassan (2003) investigate the impact of financial deregulation on DEA-type Malmquist TFP index for Turkish banks and find that financial deregulation improved the productivity of Turkish banks. Nakane and Weintraub (2005) investigate the productivity of banks in Brazil and find that private banks are more productive than state-owned banks implying that privatisation along with deregulation contributed to the increased productivity of private banks. Tirtiroglu et al. (2005) investigate the impact of US deregulation on bank TFP growth and find intrastate branch deregulation has a positive long-run impact on

productivity growth of US banks. Zhao et al. (2008) investigate the impact of financial deregulation on the productivity of commercial banks in India from 1992 to 2004 and indicate that technological innovation improve the banking industry productivity growth.

At cross-country level, Tanna (2009) investigates the impact of foreign direct investment (FDI) on bank productivity for 75 countries over the period 2001-2004 and find that FDI has a negative short-term level effect but a positive long-term rate effect on TFP growth, suggesting that spoillover effects associated with FDI inflows are dynamic leading to a lagged productivity effect.

3.5 Conclusion

This chapter reviews the literature on the banking sector related to risk taking, efficiency and productivity.

Studies relating to bank risk raking have addressed the association with policy and market influences like the role of deposit insurance, regulation, competition and financial liberalisation. This evidence seems to suggest that bank risk taking increases with charter value, but this is generally mitigated with sound regulatory policies and institutional quality that promotes market discipline.

With regard to bank efficiency, the literature is quite broad and extensive. Early studies focused on the impact of size on bank efficiency and evidence shows that there is generally a U-shaped relationship between average costs and size, implying that smaller banks are more likely to have scale economies but this diminishes with larger size. Among more recent studies, researchers have studied the impact of regulatory, market and environmental factors, and found that regulation and competition have significant impact on bank efficiency at cross country level. However, empirical evidence on the impact of financial liberalisation on bank efficiency is rather limited.

With regard to studies relating to bank productivity, evidence based on individual country studies shows that financial deregulation generally improves bank productivity. While some recent cross-country studies have addressed the issue of the impact of regulation and environmental effects, there is little empirical research done to investigate the impact of financial liberalisation on bank productivity.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

This chapter reviews the main research methods and provides an overview of the frontier methods of measuring the performance of banks. These include the basic concepts of efficiency and productivity, various types of efficiency, and various methods to estimate bank efficiency and productivity.

Generally, the efficiency estimation methods include parametric (econometric) and non-parametric (mathematical) approaches, and the frontier is classified deterministic and stochastic. The parametric approach needs specific production, cost, revenue, or profit function and error terms assumptions while non-parametric does not require functional forms and assumptions on the error terms. More specifically, there is a huge number of studies mainly applying stochastic frontier approach (SFA & Parametric) and data envelopment analysis approach (DEA & Nonparametric), the methods for frontier efficiency analysis - see the survey literature of Berger and Humphrey (1997). The thesis, in the empirical chapter, will apply the SFA and the DEA methods to estimate the efficiency of banks.

To start, the chapter introduces the basic production theory about the fundamental definition of production possibility, definitions of the efficiency of banks, and the difference between productivity and efficiency. The next section discusses the frontier methods to estimate efficiency. The frontier methods measure the performance of banks against the best-practice efficiency frontier consisting of other banks in the industry. The next part discusses various approaches to define the inputs and the outputs of the bank sector. Finally, standard cost function, standard profit function, alternative profit function and Malmquist index will be introduced to analyse how bank efficiency and productivity to be measured.

4.2 Overview of frontier approach

4.2.1 Production possibility set and production frontier

Production possibility set

The production possibility set is defined as a group of all output that is produced by all possible activities of a firm. Modeling production technology function:

$$T = \{(x, y) : x \in R_+^N, y \in R_+^M, x \text{ can produce } y\}$$

Assuming,

(a) x: vector of inputs and nonnegative and $x = (x_1, ..., x_N) \in R_+^N$;

(b) y: vector of outputs and nonnegative and $y = (y_1, ..., y_M) \in R_+^M$.

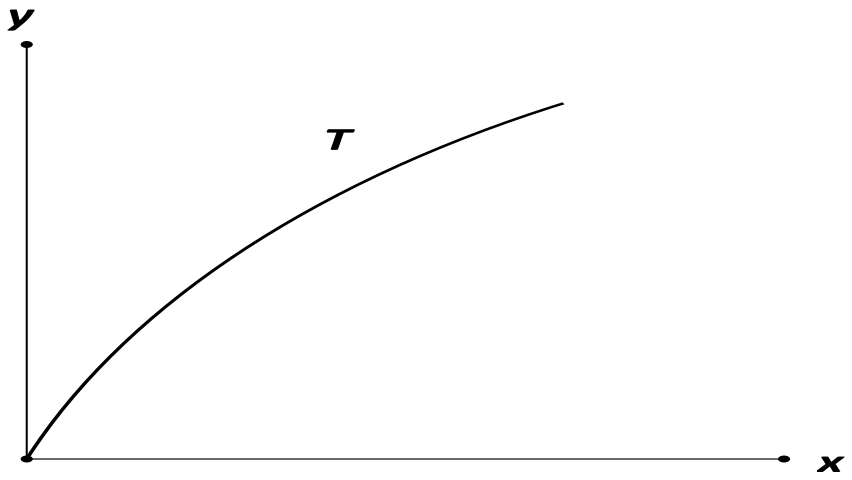

Figure 4-1 Production Technology (Production Possibility Sets)

Figure 4-1 shows the production possibility set based on the case of the combination of single-input and single-output. The production possibility set curve in Figure 4-1 describes all the possible outputs for the given inputs.

The production possibility set can also be demonstrated by the input requirement set and output requirement set. Input requirement set, assuming $y \to V(y)$ where $V(y)$ means the subset of $x = (x_1, ..., x_N) \in R_+^N$ to produce at minimum y, input requirement set is presented by $V(y) = \{x \in R_+^N : (y, x) \in T\}$. Output requirement set, assuming $x \to P(x)$, the output production set is expressed by $p(x) = \{y : (y, x) \in T\}$. Figure 4-2 illustrates the

input requirement set of production possibility. Figure 4-3 presents the output requirement set of production possibility, as a converse curve of Figure 4-2.

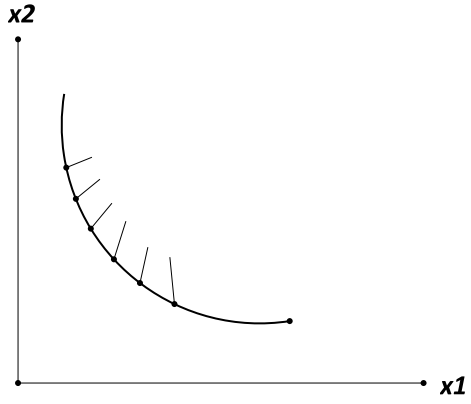

Figure 4-2 Input Requirement Set

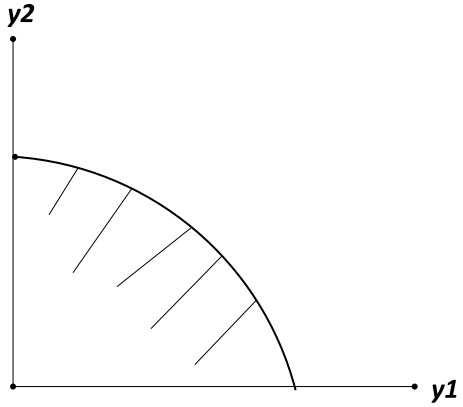

Figure 4-1 Output Production Set

Production frontier

The production frontier refers to the boundary of the production possibility set. The boundary reflects the maximum output at any given input, or uses the optimal input to produce the maximum level of output. In other words, the production possibility frontier reflects a set of the most efficient outputs, so that even with additional production, the costs will not be decreased and the profits will not be increased. The functions are presented based on input and output oriented set below:

$$f(x) = \max\{y : y \in P(x)\} = \max\{y : x \in B(y)\}$$

The production frontier can be shown graphically, as in Figure 4-4, which describes the production frontier and defines the maximum output for the given input level. A firm that operates at the production frontier is considered to be fully efficient. All the possibility combination points of the outputs and inputs of a firm are below or on the production frontier.

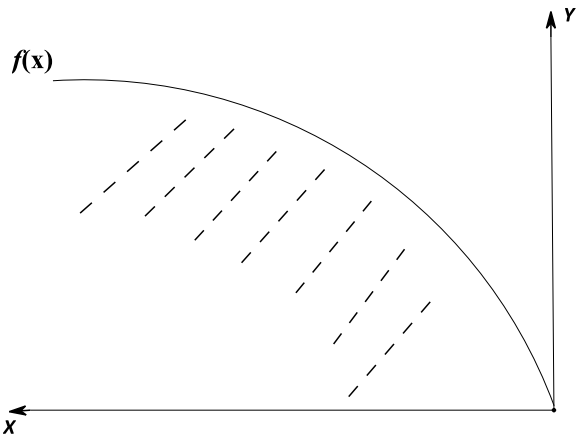

Figure 4-4 Production Frontier

4.2.2 Defining efficiency and productivity

The production process transforms a set of inputs into outputs, and there are two concepts commonly used to measure the performance of firms: productivity and efficiency. According to the work of Lovell et al. (1994), productivity refers to the ratio of outputs to inputs, as shown in the equation: Productivity = Output(s) / Input(s). While there is no precise definition of efficiency, Coelli et al. (2005) suggest efficiency reflects the ability of the firm to produce the maximum outputs for the given set of inputs. When a firm produces at the level of maximum outputs from the set of inputs, it is considered as an efficient firm. The improvement of productivity refers to either more outputs are produced from the same amount of inputs or that fewer inputs are required to produce the same level of outputs (Rogers, 1998). The efficient level (highest level of productivity) is achieved when the maximum outputs are produced from a particular set of inputs (Rogers, 1998). Therefore, productivity growth reflects the change of efficiency with increased efficiency resulting in higher productivity.

4.2.3 Types of efficiency

Theoretically, according to microeconomic theory, a firm that is believed to be efficient maximises its output at the given level of input, or minimises the costs of producing the given output. The economic efficiency of a firm can be illustrated by cost minimisation or revenue maximisation. Cost efficiency concerns the output level and the relative input level, and investigates how efficient firms use their input and whether or

not the firms use the cheapest method of production. On the other hand, revenue efficiency investigates whether firms attained maximised revenue from outputs at the given level of input and output prices. Berger et al. (1993) indicated three types of efficiency, namely x-efficiency, economies of scale and economies of scope. X-efficiency is generally related to the way in which resources are used optimally to produce output, and involves technical efficiency and allocative efficiency. Thus, if a firm does not produce at the level of minimum costs or maximum profitability, the firm is considered to be technically inefficient, allocative inefficient, or both. Firms operating via scale economies are firms that have a stable return on a scale that relates to the optimal size of the operating activities. Firms that have scope economies operate according to whether the costs decreased or increased when the outputs were broken down from single-firm producers to multi-firm producers. The concepts of x-efficiency, scale economies and scope economies are discussed in more detail below.

4.2.3.1 Economies of scale and scope

Since the economic scale and scope of banks will not be measured in the empirical analysis, this section will briefly introduce these two concepts in order to provide a better understanding of the cost and profit efficiency of banks.

Economies of scale

The concept of economies of scale refers to average unit cost decreasing with increased quantity of output. The analysis of economies of scale is generally related to long run average cost (LAC), long run marginal cost (LMC), and a set of short run average cost (SAC) and short run marginal cost (SMC). The average cost curve presents the minimum average cost per unit of production at various output levels, and marginal relates to the extra costs of production from adding one additional unit of output (Kalish Iii and Gilbert, 1973). In Figure 4-5, on the left of point $Q_{m,}$ curve of LAC is declining until the point of Q_m and LMC is below LAC, and then LMC starts to ascend. Point of Q_m is the lowest point of LAC, and LMC and LAC cross at this point (Q_m). Here, when the curve of LMC is lower than the curve of LAC economies of scale are said to exist. On the contrary, with diseconomies of scale, the curve of LMC is above LAC because increased output leads to more average costs. In other words, Humphrey (1990) indicates

that the declining slope of the LAC curve presents scale economies, the ascending slope of the LAC curve implies diseconomies of scale. Measurement of economies of scale is said to be: $S = \frac{C(q)}{MC(q)q} = \frac{AC(q)}{MC(q)}$ where C is the cost function, AC is average cost, MC is marginal cost. Cases when $S > 1, = 1, < 1$ represent economies of scale, constant scale, and diseconomies of scale respectively.

The analysis of scale economies above is based on single-input and single-output production processes. When considering multi-production firms, the outputs are generally heterogeneous. This may create difficulties in calculating the total output. The ambiguous calculation of total outputs might cause uncertainty when defining the average cost. Thus, Baumol et al. (1988) constructed the ray average cost curve (RAC) in order to analyse the average cost in multi-product firms.

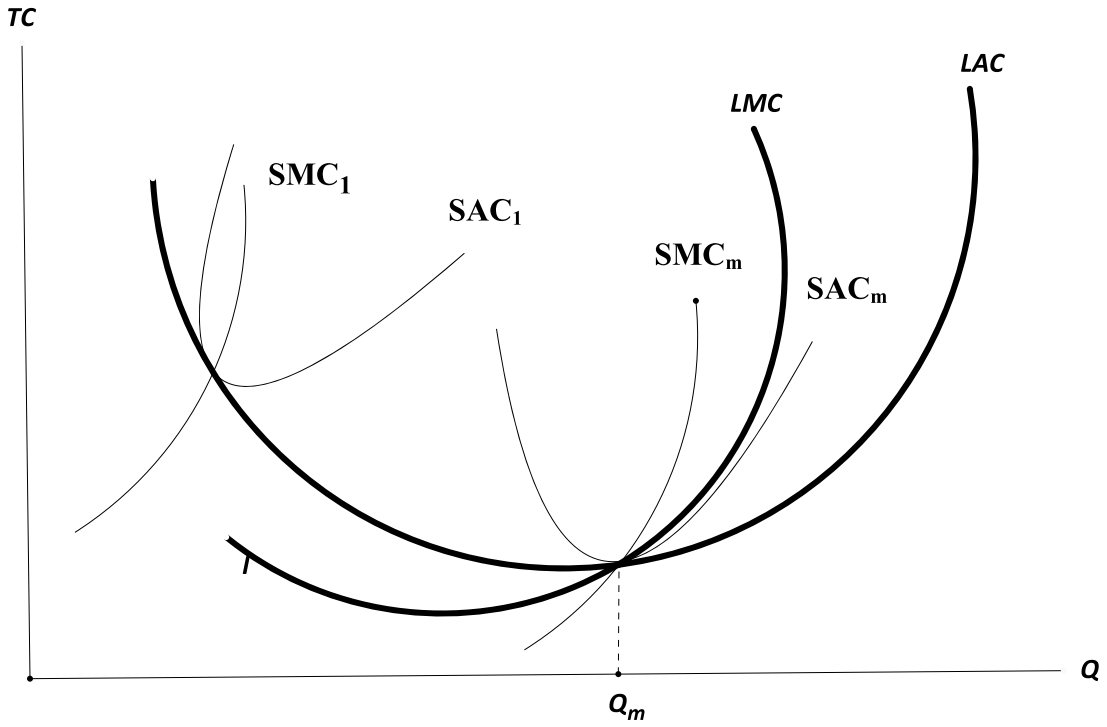

Figure 4-5 Economies of Scale and Average and Marginal Cost Curve
(Source: Humphrey, 1999)

Ray Average Cost (RAC)

Baumol and Braunstein (1977) indicated that, although it is difficult to calculate a certain index of output for a bundle of heterogeneous products, it is possible to estimate the average cost, based on output production according to a fixed proportion. They define $RAC = C(ky')/k$, where y' is the ray of output that is equal to unity, C is the cost function, k is the number of units in the bundle. RAC is strictly declining (scale economies in the single product case) if $\frac{C(ky')}{k} > \frac{C(vy')}{y}$ for $v > k$.

The economies of scale is said to be measured by: $S = \frac{C(q_1, q_2)}{MC_1 q_1 + MC_2 q_2}$

Or, for more than two productions: $S = \frac{C(q_1, q_2, ..., q_n)}{MC_1 q_1 + MC_2 q_2 + ... + MC_n q_n}$ based on the assumption that output proportions are predetermined.

With regard to the banking sector, the scale economies of banks are generally associated with the size of the banks. A proportionate increase in a bank's outputs leads to a proportionate, less proportionate, or more proportionate increase in costs. Banks are said to be operating according to a constant return to scale, an increasing return to scale or a decreasing return to scale, respectively. Clark (1988) indicates that banks are considered to exhibit scale economies if the increase in input, or the cost of production, increases proportionately less than does the output, in conjunction with the appropriate technology. Thus, if the average production costs decline when the output is raised, the firm is considered be operating according to scale economies. Benston (1972) suggests that the main source of scale economies is larger firms employing labourers that are less skilled, while taking advantage of automation. For example, the development of information technology relies on the use of computers that process a large number of transactions by increasing a small cost per transaction; thus, the total production cost of the firm is decreased.

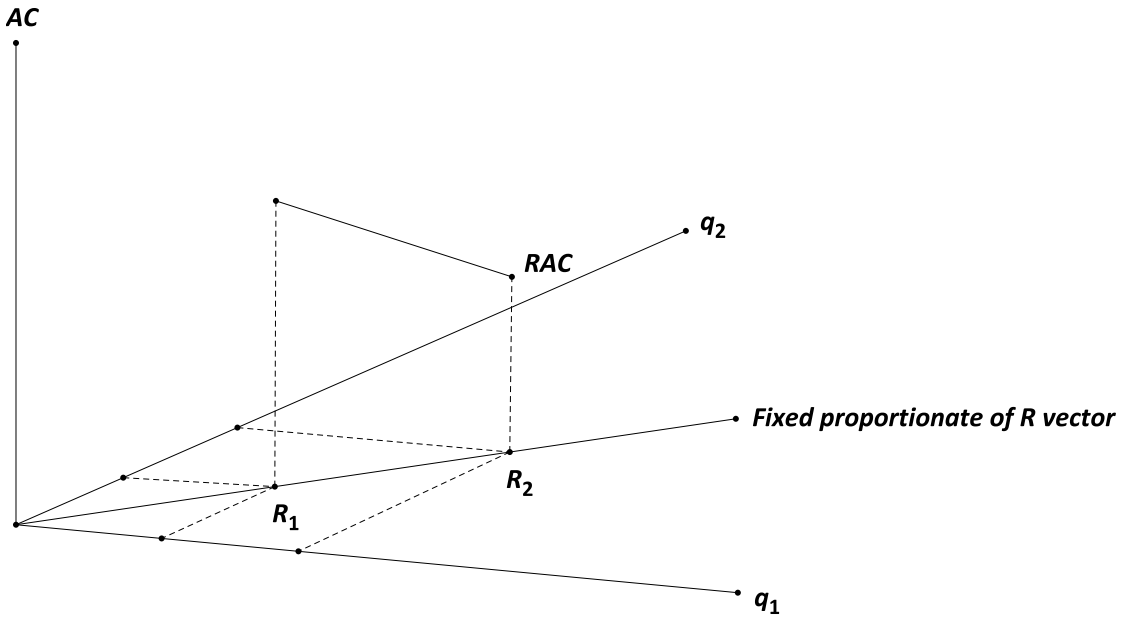

Figure 4-6 Ray average cost

Economies of scope

The concept of economies of scope refers to the cost saving from producing a combination or group of goods rather than producing a single output. Figure 4-9 illustrates the concept of scope economies. The concept of economies of scope that compares $TC(Q_1,0)+TC(0,Q_2)$ the amount of heights of cost surface at point of Q_1 and Q_2, with $TC(Q_1,Q_2)$ the heights of cost surface at point of (Q_1,Q_2) that is the vector sum of $(Q_1,0)$ and $(0,Q_2)$. When $TC(Q_1,Q_2)$ lies below the hyperplane of OAB, a firm would be said to show scope economies. The point of D, equals $TC(Q_1,0)+TC(0,Q_2)$, because the hyperplane OAB equals $TC=aQ_1+bQ_2$, a and b are defined as constant. $TC(Q_1,0)=aQ_1$ and $TC(0,Q_2)=bQ_2$, and $TC(Q_1,Q_2)$ should be less than aQ_1+bQ_2, for there to be scope economies (Baumol et al., 1988).

Mester (1994) introduces the source of scope economies in the banking sector. For instance, using the same inputs to produce diversified outputs, one bank shares a group of tellers to handle a number of savings accounts and uses the same information to evaluate several of the credit loan applications for the same clients. Thus, it is more

efficient and less costly than processing the saving and loans applications in different banks. Berger (2000) suggests that the economies of scope in the banking sector come from incorporating a variety of financial services into universal-type institutions. For example, the consolidation of commercial banks with insurance services allows for the sharing of information regarding the same customers, which might lower the costs. Thus, the scope efficiency in the banking sector usually results from joint information or financial services.

Figure 4-7 Scope Economies
(Source: Baumol, Panzar, and Willig, 1988.P.72)

4.2.3.2 Measuring efficiency

The microeconomic theoretical measurements of efficiency might be traced back to the seminal work of Farrell (1957), who indicated that the efficiency of firms includes technical efficiency, allocative efficiency and productive efficiency. This is based on the frontier model, whereby the combination of technical efficiency and allocation efficiency equals productive efficiency. In turn, Lovell et al. (1994) introduce the concept of productivity efficiency as the ratio of observed outputs to maximised potential outputs

based on given inputs, or the ratio of minimum potential inputs to observed inputs to make given outputs. Thus, productive efficiency consists of two parts, namely technical efficiency (maximum output at the given level of input) and allocation efficiency (optimal usage of input at the given price). When firms are both technically and allocatively efficient, they can be considered to be productively efficient, which is also called overall efficiency (Farrell 1957). However, Coelli (1996) argues that technical efficiency could also be decomposed into pure technical efficiency and scale efficiency. When firms operate under a variable return to scale (VRS), the distance between the observations and the frontier is considered to indicate pure technical efficiency. It is a measure that reflects managerial performance in the production process of organising inputs to outputs. Otherwise, scale efficiency measures the distance between the frontier based on the constant return to scale and the frontier based on the variable return to scale. The concept of economic efficiency is broadder than that of technical efficiency, since it allows for both technical and allocative efficiency as represented by the optimal mixed set of inputs and outputs in reaction to market prices and possibility production technology. Therefore, a firm might be technically efficient or allocatively efficient, but not be economically efficiency.

According to Farrell (1957), the concepts of productive, technical and allocative efficiency can be explained graphically through two approaches: input-oriented measurement and output-oriented measurement. Input-oriented measurement refers to keeping the proportion of outputs constant while decreasing the proportion of inputs. Output-oriented measurement involves increasing the proportion of outputs while keeping the proportion of inputs unchanged.

Input-oriented efficiency

Figure 4-8 illustrates the relationship among technical efficiency, allocative efficiency and productivity efficiency through input-oriented measurement that was described by Farrell (1957).

Two assumptions:

(a) The production frontier function is known as: $Y = f(x1, x2)$.

(b) Assuming constant return to scale that $f(x1/y, x2/y) = 1$ means when inputs change, outputs change in the same proportion (CRS[6]).

There are two inputs: x1, x2, the combination of inputs to produce the vector of Y, single output: Y, SS' is the isoquant donating various combination of inputs x1, x2 to produce fixed unit output Y based on available production technology, and SS' also refers to the technical efficiency isoquant curve such that that all points lying on the isoquant are said to be produced efficiently. AA' refers to the isocost. The optimal operating point is Q', the tangency between the isoquant and isocost curves. At this point, the firm is said to be operating at overall cost efficiency. According to Farrell (1957), the level of technical efficiency was expressed by:

$$Technical\ Efficiency = OQ/OP = 1 - QP/OP$$

Where the ratio of OQ/OP reflects the level of technical efficiency of a firm to produce a unit of output at point P. Point P reflects the firm operating at both technical inefficiency[7] and allocative inefficiency to produce unit of output. When a firm decreases inputs from P to Q, point Q refers to a firm using the group of inputs $(x1, x2)$ of the same ratio as of point P, the output is not decreased. For example, proportion of inputs at point P might be decreased since employing more *advanced technological* equipment Therefore, $1 - OQ/OP$ refers to the level of technical inefficiency of unit output and reflects percentage of input combination $(x1, x2)$ could be decreased (the ratio of $x1/x2$ is constant) without decreasing the output. The allocative efficiency is expressed by:

$$Allocative\ Efficiency = OR/OQ$$

AA' is the curve of isocost presents input price ratio. OR/OQ donates level of allocative efficiency and represents the usage of optimal inputs combination that is based on the specified price at point of P. The allocative inefficiency is expressed by $1 - OR/OQ$. The allocative inefficiency might result from inappropriate usage of inputs, for example, inappropriate proportions usage $x1$ and $x2$.

The distance of RQ refers to the production costs that could be reduced from Q to Q'. Point of Q' means both technical efficiency and allocative efficiency, point of Q only

[6] CRS refers to constant returns to scale.
[7] Since the firm is not operating at the technical efficiency isoquant curve (SS').

technical efficiency but allocative inefficiency. The distance of RP means the production costs could be reduced from P to minimize cost of point Q'. Therefore, the overall efficiency (Farrell 1957) or the productive efficiency is written by:

$$Overall\ Efficiency = OR / OP = TE \times AE$$

Where the ratio of *OR/OP* refers to overall efficiency, therefore, the inefficiency could be expressed as 1- *OR/OP* the distance from R to P.

On the other hand, economists suggest relaxing the assumption of constant returns to scale (CRS), technical efficiency could be decomposed into pure technical efficiency (PTE) and scale efficiency (SE). Figure 4-9 shows pure technical efficiency and allocative efficiency that is based on the assumption of single input and single output. OC refers to the production possibility frontier and features constant returns to scale. MNL is production possibility frontier and features variable return to scale. Assuming a firm product at the point of Q, considering variable return to scale, pure technical efficiency equals RP/RQ, the firm could diminish the usage of proportion of inputs for employing advance technologies. Scale efficiency equals RS/RP, then TE= PTE*SE=RS/RQ. The point that lies on the curve of MNL frontier can be described as pure technical efficiency.

Figure 4-8 Technical Efficiency & Allocative Efficiency (Input-Oriented)
(Source: Kumbhakar and Lovell, 2000)

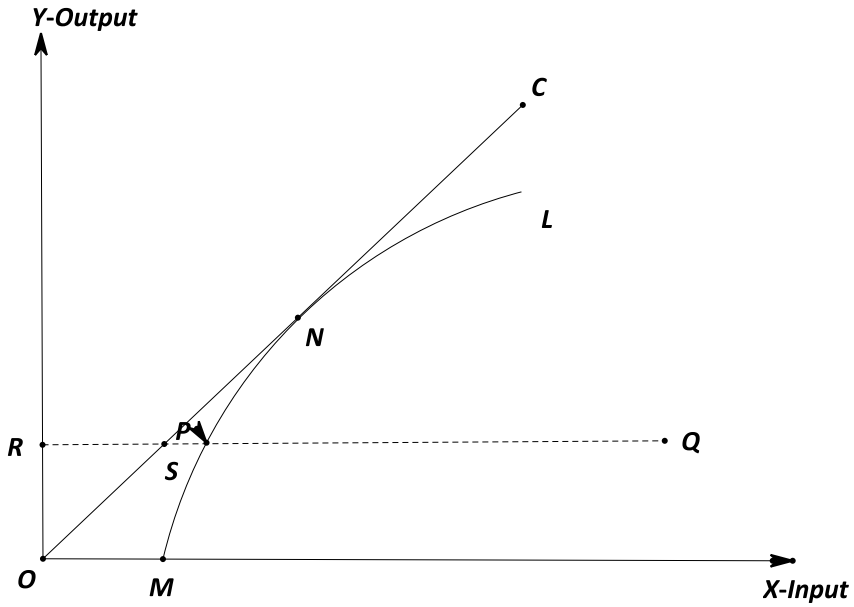

Figure 4-9 Pure Technical Efficiency, Allocative Efficiency

Output-oriented efficiency

Technical and allocative efficiency can also be measured by an output-oriented method in Figure 4-10. Firms produce group of outputs y1 and y2 that falls inside of output requirement set, if the point lies on the isoquant curve, it is said to be efficient. In Figure 4-10, point of C is inefficient, firms might expand to point D that lies on the isoquant curve.

$Technical\ Efficiency = OC / OD$ based on the assumption of constant return to scale.

LL' is the isorevenue curve, while point of D is technical efficiency, point E and point D lie on the isoquant, however, the revenue at point E is higher than point D, thus the firm should expand outputs from the point C to B in order to achieve the same level of revenue (Kumbhaker and Lovell 2000).

$\text{Re}venue\ Efficiency = OC / OB$

$Allocative\ Efficiency = RE / TE = OD / OB$

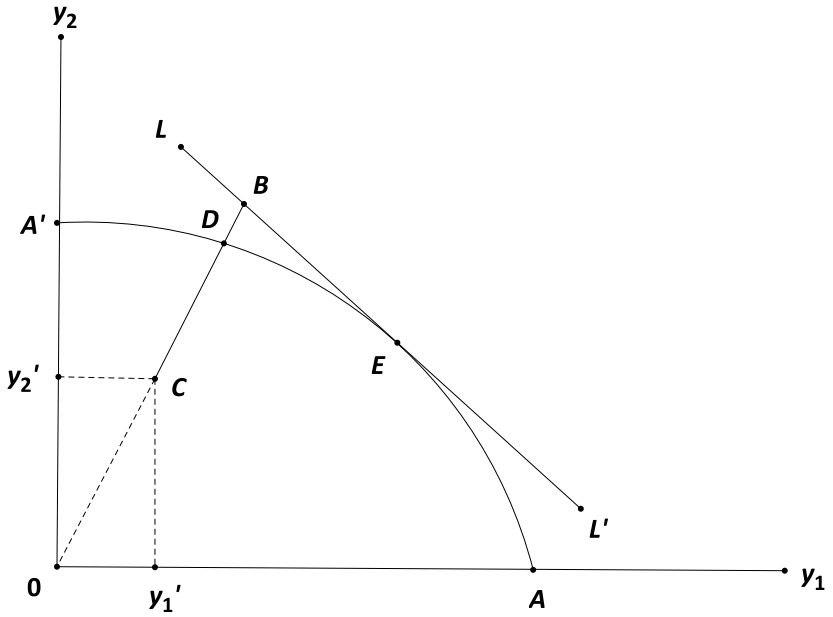

Figure 4-10 Technical and Allocative Efficiency (Output-Oriented)

4.3 Methods to estimate efficiency

4.3.1 Financial ratios

Financial ratios, such as the ratio of return of assets (ROA) and the, return of equity (ROE), which are calculated from the financial statements, are still widely used to represent the performance of banks. The advantage of using financial ratios is that most of them can be collected or recombined directly from financial statements. However, banks are characteristic of multi-output and multi-input firms. They use the group of inputs to produce a set of financial services as outputs. The traditional financial ratio approach seems not to be an appropriate way to measure the efficiency of banks as multi-output and multi-input firms. Accompanied by rapid growth in the literature regarding the frontier efficiency methods, the conventional financial ratio analysis has become obsolete in most of the studies. Berger and Humphrey (1997) suggest that the frontier efficiency analysis is much more appropriate to measure the performance of firms or banks than is the traditional financial ratio analysis, since the traditional financial ratio approach uses the ratios (return on assets, return on equity or cost/revenue) that simultaneously explain the related outputs and inputs, even if they have different input prices. In turn, Bauer et

al. (1998) suggest using the frontier efficiency estimation to diminish the prices or other exogenous factors that might affect the traditional financial performance ratio.

4.3.2 Frontier efficiency

The frontier efficiency method has been used in numerous studies on the efficiency of banks. In microeconomic terms, a set of outputs can be produced by a combination of inputs that is represented by a production possibility set. The frontier of a production possibility set represents the maximum output. Firms that lie on the frontier curve are believed to be efficient because they produce the maximum output for the given input. By contrast, firms that lie inside the frontier curve are believed to be inefficient, since they could produce more outputs using the current inputs or they could reduce the inputs and still produce the same level of outputs. The frontier efficiency method measures the efficiency frontier of the best-practice banks in the sample and estimates the deviation of an individual bank from the efficient boundary (performance of the best-practice bank). The deviations from the boundary are considered to indicate inefficiency. Farrell (1957) first introduced the frontier analysis. It measures the efficiency frontier of firms and analyses inefficiency, measured by the distance between the observed value and the frontier value. Generally, the efficiency frontier was calculated from the firms that were the most efficient sample in the data Inefficiency might result when producers chase the goals of minimising costs or maximising profits in the production process. Efficiency is scored from 0 to 1. For example, if the efficiency of a firm were scored as 0.6 (60%), this implies that the firm has 0.4 (40%) potential improvement of their efficiency.

The frontier efficiency estimation methods include parametric (econometric) and non-parametric (mathematical) approaches, and the frontier is classified as being deterministic and stochastic. More specifically, the parametric approach requires specific production, cost, revenue, or profit function and error term assumptions. On the other hand, the non-parametric approach has less restriction on the estimation of the efficiency;

for instance, it does not require functional forms and assumptions regarding the error terms[8].

Four parametric and nonparametric frontier approaches are used to estimate a bank's efficiency. These are the Data Envelopment Analysis Approach (DEA), the Stochastic Frontier Approach (SFA), the Thick Frontier Approach (TFA) and Distribution-Free Approach (DFA). Each of these approaches should measure the frontier of the best-practice banks among the samples and then measure how close each individual bank is to the frontier.

4.3.3 Parametric econometric approach

There are three parametric approaches to estimating efficiency: the Stochastic Frontier Approach (SFA), the Thick Frontier Approach (TFA) and the Distribution-Free Approach (DFA).

The seminal work by Farrell (1957), which is widely used in frontier analysis, introduced one the of basic assumptions of the parametric frontier econometric approach and identified the functional forms of the cost, profit and production frontiers that are linked to inputs and outputs, while the non-parametric approach does not need to specify functional forms. The parametric econometric models are divided into deterministic and stochastic frontiers. The difference between deterministic and stochastic frontiers is whether they allow for random shocks. The stochastic frontier allows for random shocks, while deterministic frontier does not. In other words, the deterministic frontier treats observed outputs relative to the most efficient outputs as technical inefficiency. According to Kumbhakar and Lovell (2000), the deterministic function frontier is represented by

$$y_i = f(x_i;\beta).TE_i$$

where y_i is the scalar output of the producer i, $i = 1,.....I$, x_i is a vector of N inputs, $f(x_i;\beta)$ is the production frontier and β is a technological parameter to be measured. The technical efficiency, TE, is represented by

[8] A more detailed comparison between parametric and non-parametric approaches will be introduced in section 4.3.5, the parametric approach versus the non-parametric approach.

$$TE = \frac{y_i}{f(x_i;\beta)}$$

where the technical efficiency is defined as the ratio of observed outputs to maximum possible outputs. Thus, any production that is below the production frontier $f(x_i;\beta)$ is treated as technical inefficiency, ignoring the fact that outputs might be affected by random shocks and certain other factors that are outside of the control of the producers (Kumbhakar and Lovell, 2000). In reality, each producer might have their own production frontier for the given vector of inputs. The possible maximised level of outputs seems random.

In order to overcome the problem of determinist frontier models that do not allow for the possibility of random shocks, Aigner et al. (1977), Battese and Corra (1977) and Meeusen and van Den Broeck (1977) introduced the stochastic frontier models at the same time. An important advantage of these models is that they allow for random shocks, such as accidents and weather, and the measurement errors and statistical noise that uncontrollable elements have on the output.

4.3.3.1 Stochastic frontier approach

The main assumption of the stochastic frontier approach is that the performance of a firm is affected by the behaviour of a firm and other uncontrollable factors. The error term of the stochastic frontier approach is classified into two parts, namely the random term and the one-side error term. The random error term generally refers to measurement errors and other uncontrollable factors such as accidents, weather and luck, while the one-side error term captures inefficiency. Thus, the stochastic frontier models can be stated as

$$y_i = f(x_i;\beta).\exp\{v_i\}.TE$$

where $f(x_i;\beta).\exp\{v_i\}$ is the stochastic production frontier, $f(x_i;\beta)$ is the determinist frontier and $\exp\{v_i\}$ captures the effects of random shocks on the value of outputs. The technical efficiency is then expressed as

$$TE = \frac{y_i}{f(x_i;\beta).\exp\{v_i\}}$$

The technical efficiency was defined as the ratio of observed output to maximised outputs, influenced by $\exp\{v_i\}$.

At the same time, Aigner et al. (1977), Battesse and Corra (1977, and Meeusen and van den Broeck (1977) also introduced the stochastic production frontier, expressed as

$$y_i = f(x_i, \beta) + v_i - u_i = f(x_i, \beta) + \varepsilon_i$$

where v_i refers to the two-sided noise component and assumes it to be identified and independently and identically distributed (iid) independently of u_i, while u_i is the non-negative technical inefficiency element of the error term. y_i is restricted below the frontier of $f(x_i;\beta).\exp\{v_i\}$.

The stochastic frontier approach is commonly applied into two stages. The first is the estimation of the efficiency frontier, based on the production, cost and profit functions. The distance between the observed efficiency and the efficiency frontier that results from inefficiency and random error is then estimated.

In the stochastic frontier approach, the random item is generally assumed to have normal distribution, while the term of inefficiency follows different distributions, such as half-normal, truncated normal or gamma. This study will compare the two main assumptions, namely half-normal and truncated normal.

According to Kumbhakar and Lovell (2000), the log likelihood function was expressed as below:

Normal-half normal model

$$\ln L = \text{constant} - N \ln \sigma - \sum_i \ln \Phi\left(-\frac{\varepsilon_i \lambda}{\sigma}\right) - \frac{1}{2\sigma^2}\sum_i \varepsilon_i^2$$

where N is the number of producers (banks); $\lambda = \sigma_u - \sigma_v$; $\sigma^2 = \sigma_v^2 + \sigma_u^2$; $\Phi(.)$ is the cumulative distribution function of the standard normal distribution.

Following all the parameters are estimated, in order to estimate the technical inefficiency, Jondrow et al. (1982) illustrate the conditional distribution of $(u_i \mid \varepsilon_i)$, assuming $u_i \sim N^+(0, \sigma_n^2)$.

$$f(u \mid \varepsilon) = \frac{f(u,\varepsilon)}{\varepsilon} = \frac{1}{\sqrt{2\pi}\sigma_*}.\exp\left\{-\frac{(u-\mu_*)^2}{2\sigma_*^2}\right\} / \left[1-\Phi(-\frac{\mu_*}{\sigma_*})\right]$$

where $\mu_* = -\varepsilon\sigma_u^2/\sigma^2$ and $\sigma_*^2 = \sigma_u^2\sigma_v^2/\sigma^2$, since $f(u \mid \varepsilon) \sim N^+(\mu_*, \sigma_*^2)$, mean of the model was expressed as:

$$E(u_i \mid \varepsilon_i) = \mu_{*i} + \sigma\left[\frac{\phi(-\mu_{*i}/\sigma_*)}{1-\Phi(-\mu_{*i}/\sigma_*)}\right] = \sigma_*\left[\frac{\phi(\varepsilon_i\lambda/\sigma)}{1-\Phi(\varepsilon_i\lambda/\sigma)} - (\frac{\varepsilon_i\lambda}{\sigma})\right]$$

The mode was:

$$M(u_i/\varepsilon_i) = \begin{cases} -\varepsilon(\dfrac{\sigma_u^2}{\sigma^2}) & \text{if } \varepsilon_i \le 0, \\ 0 & \text{otherwise.} \end{cases}$$

Then the technical efficiency was illustrated by:

$$TE_i = E(\exp\{-u_i\} \mid \varepsilon_i = \frac{1-\Phi\left[\sigma_* - \mu_{*i}/\sigma_*\right]}{1-\Phi(-\mu_{*i}/\sigma_*)}.\exp\left\{-\mu_{*i} + \frac{1}{2}\sigma_*^2\right\}$$

However, the mode in normal-half normal model is zero implying the influence of inefficiency is around zero. The normal-truncated normal model overcomes such a problem that follows more distribution types.

Normal-Truncated normal model

$$\ln L = \text{constant} - N\ln\sigma - N\ln\Phi(-\frac{\mu}{\sigma_u}) + \sum_i \ln\Phi(\frac{\mu}{\sigma\lambda} - \frac{\varepsilon_{i\lambda}}{\sigma}) - \frac{1}{2}\sum_i (\frac{\varepsilon_i+\mu}{\sigma})^2$$

where N is the number of producers (banks); $\sigma_u = \lambda\sigma/\sqrt{1+\lambda^2}$; and $\Phi(.)$ is the cumulative distribution function of the standard normal distribution.

The conditional distribution $f(u/\varepsilon)$:

$$f(u/\varepsilon) = \frac{f(u,\varepsilon)}{f(\varepsilon)} = \frac{1}{\sqrt{2\pi}\sigma.\left[1-\Phi(-u/\sigma_*)\right]}.\exp\left\{-\frac{(u-u)^2}{2\sigma_*^2}\right\}$$

Where $\mu_i = (-\sigma_u^2\varepsilon_i + \mu\sigma_v^2)/\sigma^2$ and $\sigma_*^2 = \sigma_u^2\sigma_v^2/\sigma^2$.

Mean and mode were expressed by:

$$E(u_i \mid \varepsilon_i) = \sigma_*\left[\frac{\mu_i}{\sigma_*} + \frac{\phi(\mu_i/\sigma_*)}{1-\Phi(-\mu_i/\sigma_*)}\right]$$

$$M(u_i \mid \varepsilon_i) = \begin{cases} \mu_i \text{ if } \mu_i \geq 0, \\ 0 \text{ otherwise} \end{cases}$$

Then technical efficiency:

$$TE_i = E\left(\exp\{-u_i\} \mid \varepsilon_i = \frac{1-\Phi\left[\sigma_* - (\mu_i / \sigma_*)\right]}{1-\Phi(-\mu_i / \sigma_*)} . \exp\left\{-\mu_i + \frac{1}{2}\sigma_*^2\right\}\right.$$

4.3.3.2 Distribution free approach

The DFA model also allows for specified cost and profit functional forms. However, the distribution-free approach assumes that the efficiency of a firm is steady or constant over time, and does not allow a particular distribution of the error terms (Berger, 1993). More specifically, this approach requires the panel data across several years and the cost function or the profit function that was estimated, as well as the residual component, which is the deviation between the actual costs and the estimated costs of each bank. The average of the residual of each bank over the years is then compared to the average residuals of other banks. The banks with the lowest average residual are believed to be the best-practice banks, and those with the highest average residuals are considered to be the least efficient. The relative efficiency of other banks is estimated regarding where they lie relative to the best practice and the least efficiency. However, the DFA explains that the variance of efficiency is only due to the average deviations of each individual bank from the efficiency frontier, but overlooks changes to regulations, technology or other external impacts. In other words, it cannot capture the x-efficiency of firms.

4.3.3.3 Thick frontier approach

In contrast to the SFA and the DFA, the TFA does not follow any specified distribution for either inefficiency or for random error items (Berger and Humphrey, 1997). Moreover, the TFA does not estimate the efficiency of individual firms and their exact efficiency frontiers, but measures the overall efficiency and forecasts the range of efficiency. The TFA assumes deviations that are out of the range of efficiency levels, with the highest and lowest quartiles of observations (classifying samples into different categories based on size) representing random errors. Inefficiency is represented by the

deviations in efficiency between the highest and lowest observations. This approach is more appropriate for research that includes large samples. More specifically, this approach estimates the "thick frontier", instead of the best-practice cost and the profit frontier. Applying this approach, sample banks are first classified into various groups based on their size. Sample banks with same size group are classified into four "quartiles" according to their average cost. The least average cost quartile bank is considered to be the criterion for operational efficiency, in contrast to other banks with a size classification. The best and worst practices are represented by the estimation of the cost function of the lowest-quartile banks and the highest-quartile banks of banks of the same size. This approach assumes that the efficiency of all banks in the lowest-quartile is the same. The costs of individual banks that were higher or lower than the costs that were calculated by each cost functions occurred due to random error. Inefficiency was represented by the difference between two forecasted cost functions. However, it seems too subjective to use quartiles to classify banks into different categories of TFA.

4.3.4 Non-parametric approaches

4.3.4.1 Data envelopment analysis approach

The non-parametric approach[9] mainly refers to the data envelopment analysis approach (DEA) that was introduced by Charnes et al. (1978) and which was most widely used to investigate the efficiency of banks in previous studies. The DEA is an approach that estimates the efficiency of decision-making units (DMUs), expressed as the ratio of total inputs to total outputs. The DEA is non-stochastic, as it assumes that there are no random and measurement errors; thus, all deviations from the estimation frontier are believed to be a result of inefficiency. In microeconomic terms as mentioned above, firms that lie on the efficiency frontier are considered to be productively efficient. However, in reality, is it difficult to say that there is a standard production frontier for any of the industries. Different industries might have different production frontiers, influenced by the level of technological development, regulation policies and other external factors. The DEA uses linear programming to drive a non-parametric frontier. It constructs the

[9] The non-parametric approach includes the Free Disposal Hull Approach (FDH) and the Data Envelopment Analysis approach (DEA). However, Free Disposal Hull Approach is a special example of a DEA.

production frontier by estimating the actual data of firms in a specific industry. In other words, the efficiency estimated by the DEA is a relative concept for each individual firm in a particular industry. When a firm can make the same outputs with less input or can use the same level of input to produce more outputs, the DEA defines these conditions as inefficiency. However, using the DEA to estimate the efficiency of firms or banks might have some problems. For example, some banks or firms might have higher marginal costs than do others, because their input costs might be higher in their operating region than in other regions. The banks or firms that operate in such region might be less efficient than are those that operate in regions with lower input costs. Moreover, economists have argued that the most important drawback of the DEA is that this approach does not require an assumption of the efficiency distribution, nor of random error. Thus, the deviation from the frontier is considered to be an indication of inefficiency, and the DEA is sensitive to the correction of measurement data and to the number of samples. Nevertheless, the deviation from the best practice frontier might include noise and inefficiency items. Evidence seems to suggest that the DEA approach might be largely sensitive to the data. Doyle and Green (1994) suggest that, even if the sample sizes are large, the existence of sudden extreme values in the samples could still influence the DEA results.

4.3.5 Parametric econometric approach vs non-parametric approach

Evidence seems to suggest that both the parametric econometric approach and the non-parametric approach have their own merits and drawbacks; there is no consensus as to which approach is preferable for estimating efficiency. Economists have criticised the parametric econometric approaches for their strong assumptions for their models to estimate the efficiency frontier. Byrne and Wang (1991) indicate that the estimation of efficiency might change according to various functional types that have different frontiers and subjective restrictions on their functional forms. The advantage of using a non-parametric approach is that it does not need a specific production or cost function to measure the frontier. Moreover, a non-parametric approach does not require specific distribution forms for efficiency or measurement errors. However, the weakness of the DEA seems also to be obvious in that it does not require random fluctuation; thus, any

deviation from the efficiency frontier is believed to indicate inefficiency, as random errors or bad luck are not filtered out. Nevertheless, in reality, the deviations should include noise and inefficiency. Consequently, sudden extremely higher or lower observed data would influence the estimation, which has led the DEA to depend largely on sample data.

4.4 Modelling efficiency of banks: selection of inputs & outputs

In modelling the production, revenue, cost, or profit function, the most controversial problem is defining the inputs and outputs (Sealey and Lindley, 1977). Some economists choose different output and input factors, largely depending on their objects of study. However, Sealey and Lindley (1977) have argued that proper inputs and outputs should depend on the firms' economic decisions. On the other hand, another important issue that should be mentioned is that banks are multi-input and multi-output producers. Hancock (1991) indicates that most of the prior research has overlooked the characteristic of the multiple outputs of financial firms such as banks.

In the identification of outputs and inputs of banks, it is not easy to say which variables should be classified as inputs and which as outputs. Berger and Humphrey (1992) suggested that bank services are priced implicitly below the deposit interest rate, so using observed revenue flows is inaccurate for representing the relative importance of various outputs. In previous studies on bank efficiency, there are five main approaches to identifying the inputs and outputs of banks. These are the production approach, the intermediation approach, the asset approach, the user-cost approach and the value-added approach. The production approach and the intermediation approach are the most widely used in previous research. The main difference between the production approach and the intermediation approach is whether or not to treat deposits as outputs (Berger et al. (1993).

There is no consensus as to whether or not to treat deposits as outputs. Deposits were treated as outputs as they afford liquid services that involve costs, such as checking the account that banks implicitly pay to the customers. On the other hand, Berger et al. (1993) argued that deposits might also be considered as inputs for banks providing deposit services. There are five approaches to identify inputs and outputs of banks.

4.4.1 Production approach

The production approach regards banks as firms that provide financial services as outputs. Financial services refer to loanable funds and deposits that were measured by the number of these accounts as outputs, based on the use of inputs capital and labour. The problem of this approach is that it overlooks the interest costs and is only concerned with operating costs, such as the cost of employing labour and using capital to produce loans and deposits. Moreover, in reality, the number of transactions is sometimes not reported; thus, very few studies use this approach to estimate the efficiency of banks.

4.4.2 Intermediation approach

The intermediation approach refers to the banks as financial intermediaries that borrow money from units of surplus or use inputs such as labour and capital to transform these resources into loanable funds and other investments as outputs (Sealey and Lindley, 1977). In this approach, outputs of banks are loans and other earning assets. The intermediation approach takes account of both the costs of interest and the costs of operating, which have been widely used in previous studies for measuring efficiency, because the interest cost is an important part of the total cost in financial intermediaries. Berger (1992) suggested that if the interest costs were not taken into account when estimating efficiency, the results might be biased because banks tend to have large interest costs on funds instead of purchased funds. Subsequently, Berger and Humphrey (1997) indicated that the intermediation approach is an appropriate way to estimate a bank's level of efficiency. On the other hand, the production approach can be seen as more appropriate for estimating a bank branch's efficiency because at the bank level, it is easier for managers to reduce the total costs of the bank, including both financial costs and non-financial costs. However, as the branch mainly processes customers' files for institutions, the investment decisions are not controlled by the managers.

4.4.3 Asset approach

The asset approach is a variation of the intermediation approach and considers only the assets in the financial statements of the bank to be outputs. Thus, banks employ labours, use capital and collect deposits and other sources as inputs to produce loans and

other investments as outputs. The intermediation approach considers the demand deposit as the output. Thus, if there are two banks, one of which is more dependent on demand deposits and the other on collecting money from financial markets, the second will seem to be more efficient than the first as a result of using more resources in order to collect the funds

4.4.4 User cost approach

The user cost approach defines the net contribution of the factors to the revenue of banks as outputs and inputs (Hancock, 1985). In other words, asset items are considered to be outputs if the revenue from holding it is greater than is the opportunity cost of asset; if the opposite is the case, the item is treated as input. With regard to liability, if the financial cost is less than is opportunity cost, it is considered to be output; if not, it is seen as input. Hancock (1991), Fixler and Zieschang (1992) and Resti (1997) used this approach to measure efficiency.

4.4.5 Value-added approach

The value-added approach considers whether assets and liabilities that are classified as outputs depend more on the degree to which they add value than how they are allocated as operational costs. Wheelock and Wilson (1999) indicated that terms such as loans, demands, saving and time deposits that have substantial added value are considered to be outputs, while terms such as labour, physical capital and purchased funds that have little added value are considered to be inputs.

4.5 Measures of bank efficiency

Various approaches to estimation efficiency were discussed above; thus, the question now is, ‘how to measure the efficiency and productivity of banks?’ Three economic efficiency concepts were generally used in the previous literature, namely cost efficiency, standard profit efficiency and alternative profit efficiency. These measure the minimised costs and maximised profits of the firms or banks. In other words, they reflect the economic optimisation in reaction to the competition in the market and the market prices.

4.5.1 Cost efficiency and cost frontier

The cost efficiency of banks refers to the minimum costs of banks at the given level of outputs with the given input price level, and compares the minimum costs with the actual costs that produce the same bundle of outputs with the given input price. In other words, it is the ratio of minimum potential costs to observed costs. Generally, the cost frontier is estimated by a cost function, while cost inefficiency is evaluated by the deviation from the cost frontier (minimum cost).

Following Berger and Mester (1997), the cost function could be illustrated by:

$$C = C(w, y, z, v, \mu_c, \varepsilon_c)$$

where C is Variable costs, w is vector of input prices, y is vector of outputs, z is fixed inputs and outputs vector, v is set of market condition variables that might affect bank efficiency, μ_c is X-inefficiency factors that refer to less than optimal usage of the input factors at given price and increases in the cost above the optimal-practice level, ε_c is the random error that integrates measurement error and sudden high or low cost sometimes result from lucky.

Assume, $C = C(w, y, z, v) * \mu_c * \varepsilon_c$ that cost function equals the inefficiency factors (μ_c) multiply random error (ε_c) and the rest of cost function $C(w, y, z, v)$. Then, both sides are offered by natural logs:

$LnC = f(w, y, z, v) + \ln \mu_c + \ln \varepsilon_c$ where $f(w, y, z, v)$ refers to $LnC(w, y, z, v)$, $\ln \mu_c + \ln \varepsilon_c$ refers to the combination of error term and various x-efficiency measurements approaches that distinguish between $\ln \mu_c$ (inefficiency term) and $\ln \varepsilon_c$ (error term).

Assume, cost of bank b that produces outputs has the same exogenous variables $\left(w^b, y^b, z^b, v^b\right)$ with best-practice bank in the samples and adjusts the random error. The cost efficiency of bank b is expressed by:

$$Cost\ EFF^b = \frac{C^{\min}}{C^b} = \frac{\exp\left[f\left(w^b, y^b, z^b, v^b\right)\right] * \exp\left[\ln \mu_c^{\min}\right]}{\exp\left[f\left(w^b, y^b, z^b, v^b\right)\right] * \exp\left[\ln \mu_c^b\right]} = \frac{\mu_c^{\min}}{\mu_c^b}$$

where, $\mu_c^{\min}$ is the lowest value of μ_c^b for all sample banks. Berger and Mester (1997) indicated that cost efficiency is represented as the percentage of efficient usage of costs. For instance, if the cost efficiency of bank b is 90%, when compared with the best-practice bank, bank of b wastes 10% of costs. Range of cost efficiency: (0, 1], where best-practice bank equals 1 (100%).

4.5.2 Profit efficiency and profit frontier

Profit efficiency is based on the assumption that the objective of the firms is the maximisation of profit in their general operations, based on various external market conditions. Thus, the concept of profit efficiency is broader than that of cost efficiency, as profit efficiency takes into account both the revenue and the costs of production. Vivas (1997) indicates that cost efficiency only considers the input inefficiency. On the other hand, profit efficiency deals with both output and input inefficiency. Therefore, profit efficiency seems more appropriate for evaluating the overall performance of banks. Following Berger and Mester (1997), the profit efficiency function is separated into two forms, namely the standard profit efficiency function and the alternative profit efficiency function, based on the assumption that the market provides perfect competition. In other words, they debate whether or not market power should be considered in a set of output prices.

4.5.2.1 Standard profit efficiency

Berger and Mester (1997) introduce that standard profit efficiency refers to how close a firm or a bank is to attaining the maximum possible profit for specified inputs and outputs prices. It assumes other variables are controlled, there is perfect competition in markets and that inputs and outputs prices are exogenous. One of the essential implications of profit maximization of the firms is that it is impossible to produce the same amount of outputs at lower level of inputs costs. As introduced by Kumbhakar and Lovell (2000), assuming vector of output prices $p = (p_1, ..., p_M) \in R_+^M$, vector of input prices is $w = (w_1, ..., w_N) \in R_+^N$, accompanied with input production vector

$x = (x_1, ..., x_N) \in R_+^N$ and output production vector $y = (x_1, ..., y_M) \in R_+^M$ the profit function was written by:

$$\pi(p, w) = \max_{y,x} \left\{ p^T y - w^T x : (y, x) \in GR \right\}$$

Where $\pi(p, w)$ represents profit frontier, T represents the transposition, and GR means production technology, $GR = \left\{ \left(y, x \right) : x \text{ can produce } y \right\}$, that refers to the group of all possible output and input vectors. Berger and Mester (1997) defined the standard profit efficiency as the ratio of realistic profits that the bank attained to the maximum profits level that could be achieved for the best-practice bank.

The measurement of profit efficiency is expressed by:

$$\pi eff\,(y, x, p, w) = \frac{(p^T y - w^T x)}{\pi(p, w)}, \text{ provided } \pi(p, w) > 0$$

Where $\pi eff\,(y, x, p, w)$ donates the profit efficiency, as the ratio of real profit $(p^T y - w^T x)$ to the maximum profit $\pi(p, w)$. Therefore, the profit efficiency represents the distance of a bank profit to the profit frontier (the maximum profit) for the given level of inputs and outputs. For instance, the standard profit efficiency equals 0.90 that means bank or firm missing 10% of the profits that it could be expected to get.

The assumption of standard profit efficiency is that the market is perfect. The banks choose output quantities related to the input and output prices to chase the profit maximization. Therefore, it treats outputs prices as exogenous. However, taking into account the market competition imperfection such as monopoly power that may determine the outputs prices and output quantities, the standard profit frontier and cost frontier cannot employ a proper frame to estimate the efficiency of banks. Thus, the concept of alternative profit efficiency is introduced in various studies[10] to fill the gaps that both cost efficiency and profit efficiency do not meet.

4.5.2.2 Alternative profit efficiency

Alternative profit efficiency assumes output quantities and input prices as exogenous. The alternative profit efficiency represents how close the actual profit of banks to the potential maximum profit is for its given level of outputs instead of output

[10] Berger et al. (1997), Berger and Mester (1997), and Berger and Mester (2003).

prices. Berger and Mester (1997) introduced the alternative efficiency which refers to how close a firm or a bank is to attaining the maximum possible profit for specified outputs levels. According to Berger and Mester (1997) and Humphrey and Pulley (1997), the alternative profits function in log form is:

$$\ln(\pi+\theta) = f(w,y,z,v) + \ln \mu_{a\pi} + \ln \varepsilon_{a\pi}$$

Where π donates the profits of the banks; θ refers to a constant added to the profits of banks in order to ensure the positive number that is taken by natural log; y is vector of outputs; w donates input prices; z is fixed inputs vector; v is set of market condition variables that might affect bank efficiency; $\ln \mu_c$ refers to inefficiency term; $\ln \varepsilon_c$ donates error term. The alternative efficiency is written as the real profits divided by potential maximum profits:

$$Alt\ \pi\ EFF^b = \frac{a\pi^b}{a\pi^{\max}} = \frac{\left\{\exp\left[f\left(w^b,y^b,z^b,v^b\right)\right]*\exp\left[\ln \mu_{a\pi}^b\right]\right\}-\theta}{\left\{\exp\left[f\left(w^b,y^b,z^b,v^b\right)\right]*\exp\left[\ln \mu_{a\pi}^{\max}\right]\right\}-\theta}$$

Berger and Mester (1997) suggested that estimation of alternative profit efficiency is useful whenever the assumption of perfect market competition in specified prices is doubtful and that banks might have some influence on prices. Moreover, there is a different quality of outputs among various banks in the sample. Because higher quality production outputs of banks might create more revenues, then the prices and revenues are not accurately measured which will affect the results of standard profit.

Berger and Mester (1997) conclude that alternative profit efficiency may provide useful information when one or more of the following conditions are met: (a) there are substantial unmeasured differences in the quality of banking services; (b) outputs are not completely variable, so that a bank cannot achieve every output scale and product mix; (c) output markets are not perfectly competitive, so that banks have some market power over the prices they charge; and (d) output prices are not accurately measured, so they do not provide accurate guides to opportunities to earn revenues and profits in the standard profit function.

4.6 Measures of bank productivity

The main measure of productivity is total factor productivity using the Malmquist index. Following Färe et al. (1994), the output-oriented Malmquist index can be expressed by:

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{\mathrm{D}^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)} \right]^{\frac{1}{2}}$$

where M_o refers to the productivity change at time t to $t+1$; $D^t(x^t, y^t)$ is the distance function under the assumption of constant returns to scale, $D^t(x^t, y^t)$ refers output distance to production frontier under the production combination of (x^t, y^t) at time t. When the value of M_o is greater than one this indicates positive TFP growth, whilst when it is less than one it indicates decreased TFP change. The TFP index can be rewritten below:

$$\begin{aligned} M_o(x^{t+1}, y^{t+1}, x^t, y^t) &= \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)} \right]^{\frac{1}{2}} \\ &= TEFCH * TECH \end{aligned}$$

The total factor productivity change (TFPCH) is decomposed into technical efficiency change (TEFCH), which is how close a bank is to the frontier, and technological change (TECH), which corresponds to the shift of the best practice frontier.

Färe et al. (1994) further indicate an "enhanced decomposition", which argues that the TEFCH calculation be further decomposed into pure technical efficiency change (PTECH) and scale efficiency change (SECH) for the variable returns to scale (VRS) of production technology. The pure technical efficiency change (PTECH) reflects the technical efficiency catch-up against the VRS technology frontier.

$$\begin{aligned} EFFCH &= \frac{D_{ov}^{t+1}(x^{t+1}, y^{t+1})}{D_{ov}^t(x^t, y^t)} \left[\frac{D_{oc}^{t+1}(x^{t+1}, y^{t+1}) / D_{ov}^{t+1}(x^{t+1}, y^{t+1})}{D_{oc}^t(x^t, y^t) / D_o^t r(x^t, y^t)} \right] \\ &= PEFCH * SECH \end{aligned}$$

where the subscripts of c and v refer to the constant returns to scale and variable returns to scale technologies, respectively, so that the total factor productivity change is expressed by:

$$TFPCH = PTECH \times SECH \times TECH$$

Recent bank studies that have used the above approach include (Tanna, 2009; Delis et al., 2011).

4.7 Conclusion

This chapter has reviewed the basic concepts of efficiency and productivity, such as the scale and scope economies, x-efficiency and various frontier efficiency estimation approaches, namely the parametric and nonparametric approaches. The chapter has also reviewed the alternative approaches for defining bank inputs and outputs and presented specific efficiency and productivity measurements, namely cost efficiency, profit efficiency and total factor productivity growth (Malmquist index). Both the stochastic frontier analysis (SFA) and the data envelopment analysis (DEA), being the most widely used of the parametric and non-parametric methods respectively, will be used further in the empirical analysis in order to investigate the impact of financial liberalisation on bank efficiency and productivity.

CHAPTER 5

COST AND PROFIT EFFICIENCY OF BANKS UNDER FINANCIAL LIBERALISATION

5.1 Introduction

While recent literature has addressed the issue of the impact of foreign ownership on bank efficiency and the impact of regulation and supervision on banks' cost and profit efficiency (Pasiouras et al., 2009) at cross-country level, there is no comprehensive study addressing the relationship between financial liberalisation and bank efficiency. As noted in Chapter 3, there are a limited number of individual country studies which investigate the impact of financial liberalisation on bank efficiency (Williams and Intarachote, 2002; Bonaccorsi di Patti and Hardy, 2005; Denizer et al., 2007; Kumar and Gulati, 2010), analysing the period before and after financial reforms. Another study by Hermes and Nhung (2010) investigates financial liberalisation on bank technical efficiency for Latin America region. Following the analysis and review of the literatures in Chapters 2 and 3, the main hypothesis being investigated in this (and next four chapters) is that a country's banking system benefits from financial liberalisation by operating more efficiently since financial liberalisation policies increases the level of competition in the domestic market forcing banks to operate more efficiently. As explained in Chapter 1, the empirical investigation will proceed in several stages in order to achieve the research objectives and questions outlined in that chapter.

Following discussion of the research methodology in Chapter 4, the empirical analysis will involve using both parametric and non-parametric methods in order to estimate different measures of bank efficiency. We also use a comprehensive set of indices covering different dimensions of financial liberalisation in order to conduct empirical analysis at cross-country level which enables us to investigate the effects of

financial liberalisation across different levels of economic development associated with advanced, middle-income and low-income group of countries. Furthermore, we control for cross-country differences in the regulatory, market structure, macroeconomic and financial crises environments.

In this chapter, to begin with, a stochastic frontier approach is used to estimate the cost and profit efficiency of banks. The empirical results show that financial liberalisation affects both cost and profit efficiency of banks, on average, with the effect being particularly significant in advanced and middle income countries. However, while financial liberalisation has a generally positive impact on profit efficiency, the results on cost efficiency are mixed, dependent on the measure of liberalisation used. Furthermore, both cost and profit efficiency are significantly affected by various regulatory and environmental factors, as found in previous studies (Pasiouras et al., 2009; Lozano-Vivas and Pasiouras, 2010), and additionally, by the financial crises of 2007-09. With regard to the latter, we find that despite the positive influence of financial liberalisation on profit efficiency, the latter declines significantly over the post-2007 crises period, whereas cost efficiency remains relatively stable.

The remainder of this chapter proceeds as follows. Section 5.2 discusses the stochastic frontier methodology and the model specification for the estimation of cost and profit efficiency and outlines the data, empirical model and variables; Section 5.3 presents the empirical results; Section 5.4 presents robustness analysis conducted at various levels; and Section 5.5 concludes this chapter.

5.2 Estimation of cost and profit efficiency

5.2.1 Stochastic cost frontier and profit frontier

This chapter uses the stochastic frontier analysis approach that was initially introduced by Aigner et al. (1977) and Meeusen and van Den Broeck (1977) to measure the cost and profit efficiency of banks. They introduce the stochastic frontier methodology to estimate the relative performance of decision making units by calculating the efficiency scores objectively and ranking them correspondingly. In stochastic frontier analysis, if the cost of a bank is higher or the profit of a bank is lower than that of the "best-practice" bank, then it is treated as relatively inefficient. This is because the "best-

practice" bank produces the same outputs under unchanged existing environment accompanied by different external random error or statistical noise. The efficiency score of each bank reflects how close it is to the "best practice" frontier. This chapter analyses cost and profit efficiency, therefore the cost/profit efficiency of banks refer to the deviation of the observed cost/profit value from the cost/profit efficient frontier. Such deviation might possibility be the result of random noise (e.g. measurement error) or inefficiency terms. Thus, cost efficiency reflects how close the actual costs of an individual bank approximate to best-practice bank (the minimum costs) to produce the given level of outputs with input prices and with existing levels of technologies (Reifschneider and Stevenson, 1991). Similarly, profit efficiency reflects how close the profits of the individual bank are to the best-practice bank (the maximum profits) under the same conditions. In reality, it is hard for all banks to operate at the efficient cost or profit frontier, since they might suffer technical inefficiency or allocative inefficiency or both. Furthermore, cost efficiency is not necessary for profit efficiency. For example, investment in new advanced technology might increase cost, but this is expected to increase revenue and profit, thus lowering cost efficiency while improving profit efficiency (Vu and Turnell, 2011).

5.2.2 Model specification

This chapter uses the Battese and Coelli (1995) method to estimate the efficiency of banks. This method allows for the estimation of efficiency scores using a stochastic cost or profit function with some specified terms relating to the inefficiency of banks in a one-step estimation model[11].

Generally, the cost function can be written as:

$$\ln C_{i,t} = C(q_{i,t}, p_{i,t}; \beta) + \varepsilon_{i,t} \qquad i = 1, 2, ..., N; t = 1, 2, ..., T \qquad (1)$$

[11] This supersedes the alternative two-step estimation method, introduced by Pitt and Lee (1981), where the first-step estimates the stochastic production function and predicts the influence of inefficiency. The second-stage specified then regresses inefficiency scores on other variables to estimate how they affect the inefficiency. However, Coelli (1996) suggests that the two-stage estimation method is inconsistent with its assumption for the inefficiency effects are considered as independent factors. Also, Wang and Schmidt (2002) indicate that the two-step estimation method might induce some bias because the model of the first-step is mis-identified. In contrast, the one-step estimation method of Battese and Coelli (1995) can resolve such bias problem through it properly identified distribution of outputs based on given inputs and other inefficiency variables in a single step.

where $C_{i,t}$ refers to observed total cost of bank i at the time t; $q_{i,t}$ refers to the vector of banks outputs; $p_{i,t}$ is the vector of input prices with proper function form; β is a vector of unknown scalar parameters that connect with the output and input variables in the cost function. Therefore, $\ln C_{i,t} = C(q_{i,t}, p_{i,t}; \beta)$ is the predicted log cost function that the bank operates for cost minimization at the given $(q_{i,t}, p_{i,t})$. $\varepsilon_{i,t}$ is the error term of the cost function that can be represented by $\varepsilon_{i,t} = u_{i,t} + v_{i,t}$, where $v_{i,t}$ s are the random errors representing the statistical noise and assumed to be independent and identically distributed (i.i.d) with $N(0, \sigma_v^2)$; $u_{i,t}$ s are non-negative random inefficient terms which are assumed to be independent but not identically distributed, thus $u_{i,t}$ follows a truncated-normal distribution, is obtained by truncation (at zero) of the $N(m_{i,t,}\sigma_u^2)$ distribution with mean given by:

$$m_{i,t} = z_{i,t}\delta \qquad (2)$$

where $z_{i,t}$ is the vector of observable explanatory variables (bank and country specific variables) that might be considered as representing the effect of inefficiency of bank i at time t. Here δ is a vector of parameters to be estimated. Following Battese and Coelli (1995), the coefficients of equations (1) and (2) are estimated simultaneously in a single-step using maximum likelihood.

A translog function[12] is typically employed in the parametric approach to estimate the inefficiency of every individual bank relative to the best practice bank. The translog function is represented by a second-order Taylor expansion that is most commonly employed in previous studies, as it allows for more flexibility when evaluating the efficiency frontier. The cost function is written by:

[12] Some other studies rely on the Fourier Flexible (FF) specification to estimate efficiency (e.g. Mitchell and Onvural, 1996; DeYoung and Hasan, 1998; Rossi et al., 2009). Mitchell and Onvural (1996) indicate that the Fourier Flexible specification can represent a broader range of cost structures than other functional forms of the banking industry. However, Berger and Mester (1997) found that both the translog and the FF function form yielded essentially the same average level and dispersion of measure efficiency, and both ranked the individual banks in almost the same order. However, Altunbas and Chakravarty (2001) compare the FF and translog specifications and urge caution about the growing use of the former to investigate bank efficiency. We therefore, use the tranlog specification as in several other recent studies (e.g. Pasiouras et al. 2009; Berger et al., 2009). We arbitrarily select this model for presentation, the remaining models being subject to similar transformations.

$$\ln\left(\frac{TC_{it}}{W_{it}}\right)=\beta_0+\sum_{j=1}^{3}\beta_j\left(Q_{jit}\right)+\sum_{k=1}^{3}\beta_k\left(\frac{W_{kit}}{W_{it}}\right)+\frac{1}{2}\sum_{j}^{3}\sum_{k}^{3}\beta_{jk}\left(Q_{jit}\right)\ln\left(\frac{Q_{jit}}{W_{it}}\right)$$
$$+\frac{1}{2}\sum_{k}^{3}\sum_{p}^{3}\beta_{kp}\ln\left(\frac{W_{kit}}{W_{it}}\right)\ln\left(\frac{W_{pit}}{W_{it}}\right)+\frac{1}{2}\sum_{j}^{3}\sum_{k}^{3}\beta_{jk}\ln\left(Q_{jit}\right)\ln\left(\frac{W_{kit}}{W_{it}}\right)$$
$$+\beta_q T+\frac{1}{2}\beta_r T^2+\sum_{j}^{3}\beta_{jt}\ln\left(Q_{jit}\right)T+\sum_{k}^{3}\beta_{kt}\ln\left(\frac{W_{kit}}{W_{it}}\right)T+u_{it}+v_{it}$$

where TC refers the total costs in natural logarithm of bank *i* at time *t*; $\ln Q_{jit}$ is output in natural logarithm; $\ln W_{kit}$ is input price in natural logarithm; T is a time trend; and β is the set of parameters should be estimated. Following previous studies, the total costs and input prices are generally normalized by one of the input prices (W_{it}) in order to impose linear homogeneity.

Regarding the profit frontier model, the explained variable is $\ln\left(\pi_{it}\right)$ instead of $\ln(TC_{it})$, where π_{it} is the total profit of bank *i* at time *t*. Hence, the profit frontier model can be written as:

$$\ln\left(\frac{\pi_{it}}{W_{it}}\right)=\beta_0+\sum_{j=1}^{3}\beta_j\left(Q_{jit}\right)+\sum_{k=1}^{3}\beta_k\left(\frac{W_{kit}}{W_{it}}\right)+\frac{1}{2}\sum_{j}^{3}\sum_{k}^{3}\beta_{jk}\left(Q_{jit}\right)\ln\left(\frac{Q_{jit}}{W_{it}}\right)$$
$$+\frac{1}{2}\sum_{k}^{3}\sum_{p}^{3}\beta_{kp}\ln\left(\frac{W_{kit}}{W_{it}}\right)\ln\left(\frac{W_{pit}}{W_{it}}\right)+\frac{1}{2}\sum_{j}^{3}\sum_{k}^{3}\beta_{jk}\ln\left(Q_{jit}\right)\ln\left(\frac{W_{kit}}{W_{it}}\right)$$
$$+\beta_q T+\frac{1}{2}\beta_r T^2+\sum_{j}^{3}\beta_{jt}\ln\left(Q_{jit}\right)T+\sum_{k}^{3}\beta_{kt}\ln\left(\frac{W_{kit}}{W_{it}}\right)T+v_{it}-u_{it}$$

Given the above specifications, the cost efficiency is estimated by: $CE_{kt}=\exp(u_i)$ where the efficiency score takes the value from one to infinity; and the profit efficiency is measured by $PEF_{kt}=\exp(-u_i)$ where the efficiency score takes the value from zero to one. To make the results comparable, the cost efficiency score is transformed by: $CEF_{kt}=1/CE_{kt}$, so that it also takes the value from zero to one. Thus, the higher score closer to 1 indicates greater efficiency of both cost and profit.

5.2.3 Data

The sample of data includes 10907 bank-year observations, covering 88 countries, and 1536 commercial banks of unbalanced panel data from the period 2000 to 2009. The data for bank-specific input and output variables are obtained from the balance sheet and income statements of commercial banks in the Bankscope Database (Bureau van Dijk Electronic Publishing). We use unconsolidated accounting data, but if the unconsolidated statements are unavailable, then consolidated accounting data are used instead[13] (Beck et al., 2010; Lozano-Vivas and Pasiouras, 2010). All input and output variables were adjusted using GDP deflators (1995 = 100). Data for each individual bank is expressed in US million dollars for a given year. The sample covers only commercial banks in order to make efficiency estimates comparable for cross country analysis. Besides, choosing only commercial banks implies that the similarity of production technology assumption implicit in the model is more realistic.

5.2.4 Definition of inputs and outputs

The selection of input and output variables is based on the intermediation approach introduced by Sealey and Lindley (1977). This approach treats banks as financial intermediaries as discussed in Chapter 4. There are three outputs: loans (Q_1), other earning assets (Q_2), and non-interest income (Q_3); and three inputs: cost of loanable funds (W_1), estimated by the ratio of interest expense/ total deposits; the cost of physical capital (W_2), measured by overhead expenses net of personnel expenses/book value of fixed assets; and the cost of labour (W_3), defined as personnel expenses/total assets. Moreover, equity is included as quasi-fixed input (E) in the cost and profit function to control for different levels of banks' risk profile, as Berger and Mester (1997) suggest that failure to control for equity might lead to a scale bias in inefficiency estimation since equity is another source for loans. They explain that dividends paid is not taking into account the overall cost, while the costs of raising equity is higher than raising deposits[14].

[13] The bank statements in the Bankscope Database have six consolidation codes (C1, C2, C*, U1, U2, U*). We select the unconsolidated statements (with codes U1 and U2), however where such statements are unavailable, we use the consolidated statements (with codes C1 and C2).

[14] According to Hughes and Mester (2008), who cite Berger and Mester (1997) and Mester (1996), it is necessary to incorporate equity as a quasi-fixed input in the empirical model so that the shadow price of

Moreover, the third input W_3 was used to normalize the dependent variables and other input prices. Table 5-1 provides the definition of inputs and outputs variables.

In addition, a time trend is included in the model (T=1 for 2000, T=2 for 2001, to T = 10 for 2009) allowing for both linear and quadratic (T and T^2) effects, to capture of effects of technological change over time. Furthermore, three dummy variables (*HIGH, UPPH, and LOWMID*) are included in the model to capture the effect of economic development (higher, upper-middle, lower-middle, and lower income countries)[15].

Table 5-1 Definition of variables used in SFA

Dependent Variables	Definition	Description
TC	Total Cost	Interest expense + Non-interest expense
PBT	Profit Before Tax	
Independent Variables		
Output Variables		
Q1	Loans	
Q2	Other earning assets	
Q3	Non-interest income	
Input Variables		
W1	Cost of loanable funds	Interest expense / total deposits
W2	Cost of physical capital	Overhead expenses net of personnel expenses /book value of fixed assets
W3	Cost of labour	Personnel expenses / total assets
Quasi-Fixed Input		
E	Equity	

Note: Summary statistics of these variables show in Appendix 5.A, Page 122.

equity is measured. Lozano-Vivas and Pasiouras (2010) incorporate this variable as a quasi-fixed input in their cost and profit efficiency models.

[15] The three dummy variables are also included in the mean inefficiency term, following Pasiouras et al. (2009) who suggest that the same variables included in both stochastic frontier and inefficiency models do not break up the independent assumption, citing Battese and Coelli (1995) "*the explanatory variables in the inefficiency model may include some input variables in the stochastic frontier*".

5.2.5 Empirical estimation model

The empirical cost frontier model is represented by:

$$\ln\left(\frac{TC_{it}}{w_3}\right) = \beta_0 + \beta_1 \ln(Q1) + \beta_2 \ln(Q2) + \beta_3 \ln(Q3) + \beta_4 \ln\left(\frac{W_1}{W_3}\right) + \beta_5 \ln\left(\frac{W_2}{W_3}\right) + \beta_6 \frac{1}{2}\left(\ln(Q1)\right)^2$$
$$+ \beta_7 \ln(Q1)\ln(Q2) + \beta_8 \ln(Q1)\ln(Q3) + \beta_9 \frac{1}{2}\left(\ln(Q2)\right)^2 + \beta_{10} \ln(Q2)\ln(Q3)$$
$$+ \beta_{11} \frac{1}{2}\left(\ln(Q3)\right)^2 + \beta_{12} \frac{1}{2}\left(\ln\left(\frac{W_1}{W_3}\right)\right)^2 + \beta_{13} \ln(Q1)\left(\frac{W_1}{W_3}\right) + \beta_{14} \ln(Q2)\ln\left(\frac{W_1}{W_3}\right)$$
$$+ \beta_{15} \ln(Q3)\ln\left(\frac{W_1}{W_3}\right) + \beta_{16} \frac{1}{2}\left(\ln\left(\frac{W_2}{W_3}\right)\right)^2 + \beta_{17} \ln(Q1)\ln\left(\frac{W_2}{W_3}\right) + \beta_{18} \ln(Q2)\ln\left(\frac{W_2}{W_3}\right)$$
$$+ \beta_{19} \ln(Q3)\ln\left(\frac{W_2}{W_3}\right) + \beta_{20} \ln\left(\frac{W_1}{W_3}\right)\ln\left(\frac{W_2}{W_3}\right) + \beta_{21} T + \beta_{22} \frac{1}{2} T^2 + \beta_{23} T \ln(Q1)$$
$$+ \beta_{24} T \ln(Q2) + \beta_{25} T \ln(Q3) + \beta_{26} T \ln\left(\frac{W_1}{W_3}\right) + \beta_{27} T \ln\left(\frac{W_2}{W_3}\right) + \beta_{28} \ln(E) + \beta_{29} \frac{1}{2} \ln(E)^2$$
$$+ \beta_{30} \ln(E)\ln(Q1) + \beta_{31} \ln(E)\ln(Q2) + \beta_{32} \ln(E)\ln(Q3) + \beta_{33} \ln(E)\ln\left(\frac{W_1}{W_3}\right)$$
$$+ \beta_{34} \ln(E)\ln\left(\frac{W_2}{W_3}\right) + \beta_{35} D_{HIGH} + \beta_{36} D_{UPPH} + \beta_{37} D_{LOWMID} + v_{it} + u_{it}$$

For the empirical profit frontier model, the specification is the same except the dependent variable is Profit Before Tax (PBT) instead of Total Cost (C), and the inefficiency term then becomes negative ($-u_{i,t}$). In addition, to account for the negative minimum profit of banks (since the dependent variable is required to be transformed into natural logarithm), we follow the transformation approach[16] suggested by Bos and Koetter (2011) to incorporate an additional independent variable (negative profit indicator: *NPI*). In this way, the dependent variable is assigned value of 1 when PBT ≤ 0, then, the additional independent variable (negative profit indicator: *NPI*) equals 1 when PBT ≥ 0 and equals the absolute value of PBT for banks with negative profits. A similar

[16] Some of the previous studies. e.g. Berger and Mester (1997), Pasiouras et al. (2009), add a constant value to convert the non-positive value of profit before tax, the absolute value of minimum profit before tax plus one and add to original value: PBT+ (| PBT^{min}|+1). However, Bos and Kotter (2011) indicate that such transformation might affect the error term which is an important aspect of stochastic frontier analysis and might also omit the information for the truncated part distribution of the dependent variable. In the appendix to this chapter, however, we also estimate bank profit efficiency through the approach ln (PBT+ (| PBT^{min}|+1)), but the efficiency results are consistent with (Bos and Koetter, 2011) result that the profit efficiency scores have lower standard deviation and are closer to the full efficiency frontier, for more detail see Appendix 5.B.

transformation approach is used by Park (2009) and Tabak et al. (2011) to estimate bank efficiency.

5.2.6 Potential determinants of inefficiency

In order to examine the impact of financial liberalisation on the efficiency of banks, while at the same time controlling for other country-specific variables, the mean inefficiency term m_{it} in Equation (2) is represented by:

$$m_{it} = \delta_0 + \delta_1 FINLIB_{it} + \delta_2 CAPR_{it} + \delta_3 SUP_{it} + \delta_4 PRIM_{it} + \delta_5 ACT_{it} + \delta_6 CONC_{it} + \delta_7 CLAIM_{it} + \delta_8 GDPGR_{it} + \delta_9 INFA_{it} + \delta_{10} HIGH_{it} + \delta_{11} UPPM_{it} + \delta_{12} LOWMID_{it} + \delta_{13} FC_{it}$$

where *FINLIB* represents a measure of financial liberalisation; *CAPR, SUP, PRIM, ACT* are four regulatory and supervision variables; *CONC* and *CLAIM* are two market structure variables; *GDPGR* and *INFA* are two macroeconomic condition variables; *HIGH, UPPM* and *LOWMID* are dummy variables to control for country groups; and *FC* is an additional dummy variable to capture the effect of financial crisis (either bank, currency or sovereign debt crisis). Table 5.A.1 in the appendix to this chapter provides further details and sources of the bank-specific and country-specific control variables. The rationale for including these variables is discussed further below.

5.2.6.1 Proxy for financial liberalisation

The study employs three alternative measures of financial liberalisation (*FINLIB*) as a proxy for both international and domestic aspects of financial liberalisation and will enter in the model separately. The international measures of financial liberalisation include the *de jure* index measuring the intensity of capital market liberalisation (Chinn and Ito, 2008) and the d*e facto* measure representing the stock of foreign liabilities over GDP (Lane and Milesi-Ferretti, 2007; Kose et al., 2009); additionally, measures of financial liberalisation provided by Abiad et al. (2008) include both domestic and international aspects of liberalisation: Interest rate liberalisation (*INTRA*), and Privatisation (*PRIVATI*), Entry barrier liberalisation (*ENTRY*), Capital account liberalisation (*CAPITAL*), Equity market liberalisation (*EQUITY*), and Credit control liberalisation (*CREDIT*).

5.2.6.2 Control variables

Regulatory and supervisory variables

There are four variables used to control for differences in banking regulations across countries and these are based on the 2001, 2003 and 2008 versions of the database originally provided by Barth et al. (2001). As in Pasiouras et al. (2009), we use the capital requirements index (*CAPR*), the index of official supervisory power (*SUP*), the index of private monitoring (*PRIM*), and the index of level bank activities restrictiveness (*ACT*). Three of these measures (*CAPR, SUP, PRIM*) are related to the three pillars of Basel II: capital requirements (first pillar), official supervisory power (second pillar), and market discipline (third pillar) (Basel Committee on Banking Supervision, 2004).

CAPR is an index that measures both initial and overall capital stringency. Overall capital stringency estimates whether capital requirement reflects certain risk elements and deducts certain market values losses from capital before minimum capital adequacy is determined, on the other hand, the initial capital stringency examines whether certain funds may be used to initially capitalize a bank and whether they are officially verified. Its value is calculated based on a set of eight questions with higher scores reflecting more capital stringency. The results of the previous empirical studies are mixed. For example, Barth et al. (2006) indicate that there is no strong correlation between the capital stringency and bank performance, whereas Pasiouras et al. (2009) show a positive impact of capital requirement on cost efficiency but a negative impact on profit efficiency of banks.

SUP measures the degree of official power of the supervisory authorities based on information relating to whether bank supervisors can take relevant actions against bank management, bank shareholders, and bank owners, with higher value of *SUP* indicating greater powers of supervision. Barth et al. (2004) show that strict supervision that can prevent bank from engaging in excessive risk-taking behaviour contributes to bank stability and development; whereas Quintyn and Taylor (2003) argue that improper regulatory and supervisory polices can lead to financial instability and strong supervisory power might relate to corruption as supervisors use their power to benefit preferred organizations. Barth et al. (2006) conclude that if public interest approach is believed then powerful supervisory should directly improve bank efficiency through the increased

competition; however, the private interest approach to supervisory power contends that effective supervision should encourage private monitoring through requiring banks to disclose information.

PRIM measures the degree of private monitoring in the regulatory approach which requires banks to release accurate and comprehensive information to the public. It takes value from 0 to 8, the higher values indicating a higher level of requirement on information disclosure and private monitoring.

ACT measures degree of restrictions on bank activities in securities, insurance, real estate investment, and ownership of non-financial firms. It takes the value from 0 to 4; the higher value indicating more restrictions. Barth et al. (2004) indicate that activity restrictions serve to limit risk-taking incentives of banks in gaining more profitability, however, it is hard to monitor complex and large banks, and large financial groups might decrease competition and efficiency.

Financial development and market structure variables

CONC measures bank concentration that is defined as a ratio of the total assets of three largest commercial banks to the total assets of all commercial banks of a country. This variable indirectly controls for the degree of competition of the banking industry, with a higher value implying less competition (more concentration).

CLAIM is the ratio of claims on the private sector to GDP that captures the depth of financial intermediation[17]. The higher ratio indicates higher level of bank activities in the economy.

Macroeconomic Variables

GDPGR is the real GDP growth rate. *INFA* is the annual inflation rate. These two variables are used to control the macroeconomic environment as in Grigorian and Manole (2002) and Pasiouras et al. (2009). *GDPGR,* the higher economic growth rate might stimulates banks more lending and represents overall economic development that positive affect the bank efficiency. The inflation rate (*INFA*) would directly influence the saving, interest rate revenue of banks. Grigorian and Manole (2002) mention that inflation captures the effect of price (net interest margin) and non-price (excessive branching) behaviour. The higher inflation rate could raise the saving and demand of the loans, so

[17] This variable was also considered as a proxy of financial development (Levine et al. 2000).

that the profits of banks (Ben Naceur et al., 2008). However, the rise in inflation might lead to the excessive branches behaviour that worsens the cost efficiency of banks (Kasman and Yildirim, 2006).

Country income-Group variables

The three dummy variables (*HIGH, UPPM* and *LOWMID)*, which represent higher, upper-middle, lower-middle income group countries, are used to distinguish the effect of these income-group countries against low income group of countries (which represent the base case), These three dummy variables effectively capture the effect of different levels of economic development (Lozano-Vivas and Pasiouras, 2010).

Financial crisis dummy variable

FC is the relevant (0/1) dummy variable which represents the effect of financial crises, which include bank, currency or sovereign debt crisis, as defined by the IMF dataset (Laeven and Valencia, 2012). The empirical results allow for the joint as well as the separate influences of these crises. Laeven and Valencia (2008) and Laeven and Valencia (2012) define systemic banking crises when a country's financial institutions such as banks suffer a large number of defaults and financial institutions face difficulties to repay their contractual obligations on time. More specifically, Laeven and Valencia (2012) define banking crises when two conditions are met, (i) significant signs of financial distress in the banking system; (ii) significant banking policy intervention measures in responses to significant losses the banking system; based on six measures of policy intervention: (1) extensive liquidity support; (2) bank restructuring gross costs; (3) significant bank nationalizations; (4) significant guarantees put in place; (5) significant assets purchases; (6) deposit freezes and/or bank holidays; when three out of the six measures are met, the policy intervention is considering significant. The currency crisis is defined as a nominal depreciation of the currency of at least 30% that is also at least 10% increase in the rate of depreciation compared to the year before. Finally, the sovereign debt crises reflect the year of sovereign defaults to private lending (Laeven and Valencia, 2008).

5.3 Empirical results

5.3.1 Cost and alternative profit efficiency scores

Table 5-2 presents the average measured cost and profit efficiency of all commercial banks for the period from 2000 to 2010 with a global frontier. It shows the efficiency estimation results by year (panel A), by geographical region (panel B), and by levels of income group (panel C). They are calculated on the basis of the common frontier (global frontier) and incorporated with controlled country-specific variables.

The results show that the cost efficiency of the total sample averages 0.8796. This suggests that, on average, 12.04% of the commercial banks' costs are wasted relative to the best-practice commercial bank among the samples, to produce the same outputs and with the same technology. Regarding the profit efficiency, the average measured profit efficiency is 0.5739. This suggests that, on average, the commercial banks could improve their profits by 42.61% relative to the best-practice bank in the samples. Comparing the overall mean of the cost and profit efficiency, it seems the level of cost inefficiency is much lower than the profit inefficiency, and this finding is confirmed by some of the previous studies (Maudos et al., 2002; Pasiouras et al., 2009). Looking at Figure 5-1, the trend for profit and cost efficiency, both efficiency scores do not fluctuate greatly during our estimation period. While profit efficiency is slightly increased from 2000 to 2005, for the period from 2006 to 2009, there is a sharp downward trend for the profit efficiency, from 0.6177 to 0.4404. One of the possible reasons for the dramatic decline of the average profit efficiency of the banks might be the external shock from the on-going global financial crisis that was initially caused by the subprime mortgage crisis in the United States.

In addition, the efficiency results are also consistent with the argument that the most cost efficient banks are not necessarily the most profit efficient banks and vice versa (Berger and Mester, 1997; Rogers, 1998; Maudos et al., 2002; Pasiouras et al., 2009). Since profit efficiency comes mainly from revenues, Maudos et al. (2002) and Pasiouras et al. (2009) suggest that it is necessary to estimate both cost and profit efficiency for banks, since focusing on cost alone would underestimate the total inefficiency. Looking at profit and cost efficiency separately, Table 5-2 (panel A) shows that for our estimation period, on average, the efficiency scores for cost range between 0.8713 in 2002 and

0.8878 in 2009. The cost efficiency, on average, decreased slightly from 2000 to 2004 from 0.8784 to 0.8758, while from 2005 to 2009 the scores for cost efficiency fluctuated. On the other hand, the efficiency scores for profit range between 0.4404 in 2009 and 0.6186 in 2005. The profit efficiency, on average, continuously increased each year, from 0.5981 in 2000 to 0.6186 in 2005, while there was a sharp downturn from 0.6177 in 2006 to 0.4404 in 2009. Moreover, Table 5-2 (panel B) illustrates the comparison by geographical region. It reveals that Western European banks are the most cost efficient, with average cost efficiency at 0.8960, followed by the Middle East and Africa at 0.8852 and Australasia at 0.8848, while the least cost efficient region is Latin America. Regarding the profit efficiency, the ranking is different. On average, the most profit efficient region is Asia Pacific (0.6306), followed by the Middle East and Africa (0.6272) and Eastern Europe (0.5934). Furthermore, Panel C reveals the mean efficiency by different categories of income group countries. On average, banks in the high income group experience the most cost efficiency, while banks in the lower and middle income groups are more profit efficient.

Figure 5-1

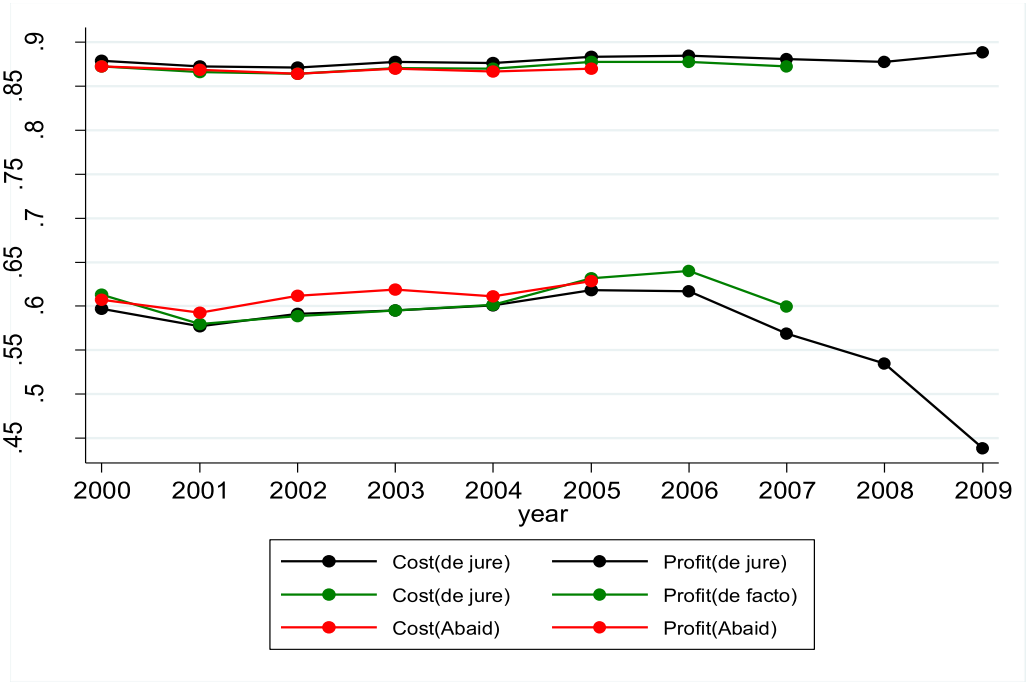

Table 5-2 Cost and profit efficiency estimation

	Number of observations	Cost efficiency		Profit efficiency	
		Mean	Std. Dev	Mean	Std. Dev
Panel A: mean by year					
2000	756	0.8788	0.0797	0.5970	0.1605
2001	816	0.8727	0.0875	0.5769	0.1617
2002	865	0.8716	0.0879	0.5912	0.1500
2003	954	0.8775	0.0889	0.5949	0.1551
2004	1121	0.8762	0.0847	0.6007	0.1526
2005	1284	0.8835	0.0773	0.6183	0.1335
2006	1339	0.8848	0.0745	0.6171	0.1339
2007	1318	0.8812	0.0826	0.5688	0.1670
2008	1248	0.8776	0.0809	0.5350	0.1870
2009	1206	0.8884	0.0719	0.4385	0.2652
Panel B: mean by geographical region					
Asia Pacific	2118	0.8704	0.0877	0.6291	0.1591
Australasia	68	0.8856	0.0414	0.5317	0.1415
Eastern Europe	1283	0.8736	0.0598	0.5925	0.1934
Latin America	1950	0.8560	0.1086	0.5589	0.1743
Middle East and Africa	1266	0.8852	0.0675	0.6256	0.1561
North America	128	0.8790	0.0528	0.5272	0.1549
Western Europe	4094	0.8964	0.0689	0.5282	0.1826
Panel C: mean by country group					
High income	5375	0.8902	0.0691	0.5392	0.1866
Upper middle income	2922	0.8700	0.0873	0.5896	0.1753
Lower middle income	2106	0.8626	0.0991	0.6125	0.1575
Low income	504	0.8992	0.0598	0.6549	0.1376
Overall mean	10907	0.8799	0.0813	0.5722	0.1797

Note: The mean value by year, geographical region and income country group are calculated from the common frontier. The geographic region classification is obtained from GMID, and the different income-group classifications are on the basis of the World Bank Database.

5.3.2 Potential correlates of efficiency

Table 5-3 shows the results of the impact of financial liberalisation and other control variables on the mean cost and profit inefficiency of banks.

5.3.2.1 Impact of financial liberalisation (*de jure* measure)

Column 1 and 4 of Table 5-3 show that the variable *FINLIB (de jure),* which captures the intensity of capital account liberalisation, has a statistically significant and positive effect on the cost inefficiency, but a statistically significant and negative effect

on the profit inefficiency of commercial banks. This implies that a higher (lower) level of financial liberalisation would lead to lower (higher) cost efficiency and higher (lower) profit efficiency of commercial banks[18]. This evidence seems to support the argument that financial liberalisation that allows capital inflows and foreign banks' entry increases competition in the banking industry and the competitive pressure stimulates banks to improve their profit efficiency, although not necessarily cost efficiency, relative to the frontier. Moreover, financial liberalisation increases mergers and acquisitions (M&A) activity, changes the market competition position, diversifies loan and credit risk and improves the profit levels of the banks (Altunbaş and Marquès, 2008). Furthermore, financial liberalisation induces advances in management and higher technology standards, which may also transforms the profit efficiency of the banking sector (Schaeck and Cihak, 2008). However, the improvement in profit efficiency does not necessarily imply higher cost efficiency. The negative relationship between financial liberalisation and cost efficiency might result from the increased costs of managing excess-risk taking behaviour, due to the more flexible and open financial market environment. Secondly, the higher costs might also come from updating banks' products and services to keep up with greater competition in the market. Thirdly, merging banks might drop their performance due to the diversity in technology and financial innovation strategies, as well as difficulty incorporating their different cultures, which would increase costs (Altunbaş and Marquès, 2008). On the other hand, the higher cost inefficiency might also motivate banks to improve their profit efficiency levels to compensate for the raised costs.

[18] Note that while the impact of FINLIB on cost inefficiency is positive on the *de jure* measure, the corresponding effect of the *de facto* measure is negative (columns 2 and 5 in Table 5-3), so the result on cost efficiency is not robust. Hence, it is argued that financial liberalisation may have a positive or negative impact on cost efficiency, and this may be associated with the measurement problems.

Table 5-3 Determinants of cost and profit inefficiency

	Cost inefficiency			Profit inefficiency		
	De jure	***De facto***	***Abiad (2008)***	***De jure***	***De facto***	***Abaid(2008)***
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-10.617***	-11.854***	-12.123***	-2.1313***	-4.8348***	-1.8955***
	(2.5959)	(2.7264)	(3.5772)	(0.3629)	(1.6638)	(0.4198)
FINLIB	0.3340***			-0.0223***		
(*De jure*)	(0.0814)			(0.0038)		
FINLIB		-0.1113***			-0.0878***	
***(De facto*)**		(0.0255)			(0.0301)	
CREDIT			-1.4003***			-0.0191***
			(0.4091)			(0.0041)
INTRA			1.1362***			0.2506***
			(0.3381)			(0.0573)
ENTRY			0.0164***			0.3235***
			(0.0060)			(0.0673)
PRIVATI			0.7320***			-0.3080***
			(0.2152)			(0.0672)
CAPITAL			0.3350***			-0.1044***
			(0.0994)			(0.0207)
EQUITY			-0.2025***			-0.1568***
			(0.0604)			(0.0359)
CAPR	-0.59642***	-0.6089***	-0.4882***	0.0208***	0.0134***	0.0126***
	(0.1466)	(0.1397)	(0.1441)	(0.0035)	(0.0047)	(0.0027)
SUP	0.24812***	0.2335***	0.0850***	-0.0241***	-0.0267***	-0.0224***
	(0.0609)	(0.0538)	(0.0248)	(0.0039)	(-0.0092)	(0.0049)
PRIM	0.61330***	0.8198***	0.9826***	0.0419***	0.2733***	0.1052***
	(0.1506)	(0.1876)	(0.2902)	(0.0069)	(0.0938)	(0.0227)
ACT	-0.93716***	-0.5025***	-0.0239***	0.1339***	-0.0984***	-0.0466***
	(0.2307)	(0.1155)	(0.0062)	(0.0234)	(0.0337)	(0.0090)
CONC	-4.45100***	-6.8843***	-10.0480***	0.3705***	0.0531***	-1.0527***
	(1.0998)	(1.5818)	(2.9618)	(0.0642)	(0.0189)	(0.2230)
CLAIM	-0.60419***	0.3357***	0.5118***	0.0459***	0.0888***	-0.2268***
	(0.1469)	(0.0792)	(0.1498)	(0.0073)	(0.0305)	(0.0481)
GDPGR	-0.00688***	-0.0116***	0.0016***	-0.0589***	-0.1400***	-0.0398***
	(0.0016)	(0.0026)	(0.0006)	(0.0100)	(0.0482)	(0.0084)
INFA	0.12554***	0.1242***	0.1904***	-0.0052***	-0.0070***	-0.0051***
	(0.0309)	(0.0287)	(0.0558)	(0.0009)	(0.0023)	(0.0010)
HIGH	0.78736***	2.2488***	1.1170***	0.5037***	0.9947***	0.7398***
	(0.1935)	(0.5173)	(0.3220)	(0.0854)	(0.3417)	(0.1640)
UPPH	1.61320***	2.0634***	-2.0648***	0.4284***	1.0740***	0.4046***
	(0.3927)	(0.4731)	(0.6092)	(0.0718)	(0.3694)	(0.0895)
LOWMID	3.31470***	4.3624***	3.0019***	0.3270***	-0.1205***	-0.2080***
	(0.8118)	(1.0027)	(0.8784)	(0.0547)	(0.0405)	(0.0419)
FC	0.90949***	1.5545***	0.0685*	0.1565***	0.4159***	-0.1046***
	(0.2216)	(0.3552)	(0.0396)	(0.0280)	(0.1430)	(0.0042)

Note: Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level. Column (1) and (4) use de jure financial liberalisation indicator; Column (2) and (5) use de facto financial liberalisation indicator; Column (3) and (6) use Abiad (2008) financial liberalisation indicator.

5.3.2.2 Impact of financial liberalisation (*de facto* measure)

Columns 2 and 5 of Table 5-3 show the results of the *de facto* measure of FINLIB on cost and profit inefficiency. This measure has a statistically significant and negative impact on both cost and profit inefficiency. It implies that a higher level of financial liberalisation improves both the cost and profit efficiency of banks. This finding is only partially consistent with that of the *de jure* measure that suggests financial liberalisation improves profit efficiency but lowers cost efficiency. The improvement of cost efficiency might result from the competitive pressure forcing banks to reduce overhead costs and improve management (Hermes and Nhung, 2010). On the other hand, this result might be associated with the discrepancy in the measurement of the two variables, as Kose et al., (2009) make the argument that various restrictions on foreign exchange which are not necessary to impede actual capital flows are captured in the *de jure* measure.

5.3.2.3 Impact of financial liberalisation (*Abiad et al. (2008)* measures)

Column 3 and 6 of Table 5-3 show the results of the impact of various measures of financial liberalisation, based on Abiad et al. (2008), on bank cost profit inefficiency. *CREDIT* refers to credit allocation liberalisation and reflects the restrictions on the funds that banks can use or allocate, which has a statistically significant and negative impact on both cost and profit inefficiency of banks. In this case, it implies that higher level of liberalisation on credit control would improve bank profit and cost efficiency. Hermes and Lensink (2008) indicate that liberalisation of government control that increases the market's power improves market conditions and competition by improving the efficiency of capital allocation, reducing overhead costs, and improving bank efficiency. *INTRA* refers to interest rate liberalisation and *ENTRY* refers to entry barrier liberalisation, the latter referring to restrictions on foreign financial institutions' entry into the domestic financial market. These two variables are statistically significant and both relate positively to the cost and profit inefficiency, suggesting that higher interest rate liberalisation and entry barrier liberalisation lead to lower bank costs and profit efficiency. Humphrey and Pulley (1997) found that deregulation of interest rates would increase costs and lower profits for US banks in the early 1980s. The higher level of elimination of entry barriers represents more intense activities by foreign financial

institutions and more competition in financial markets. Casu and Girardone (2009) indicate that competition accelerates consolidation in the banking industry, which might increase concentration. The "quiet life hypothesis" that was first introduced by Hicks (1935) argues that monopoly power benefits managers, giving them a quiet life away from competition, where managers do not need to control costs (Berger and Hannan, 1998). The effect of *PRIVATI* (Privatization) is statistically significant and positive on cost inefficiency, while when it is negative on profit inefficiency, implying that higher privatization decreases cost efficiency but improves profit efficiency. The results here support Berger et al. (2005) who found that privatization leads to profit efficiency increasing, since nonperforming loans decline substantially, while lack of cost efficiency improvement may be due to raised costs from portfolio reallocations. Concerning *CAPITAL*, the dimension of capital account liberalisation, the results indicate that higher level of capital account liberalisation lowers cost efficiency and improves profit efficiency, consistent with the results of the *de jure* measure. *EQUITY*, on the other hand, has a negative impact on both cost and profit inefficiency, implying that a liberalised equity market improves both cost and profit efficiency, consistent with results of the *de facto* measure.

5.3.2.4 Effect of regulatory and supervisory variables

Concerning the regulatory and supervisory factors, the variable of capital requirements (*CAPR*) is statistically significant and negatively related to cost inefficiency, but positively related to profit inefficiency. Therefore, higher capital requirements increase the cost efficiency, but reduce the profit efficiency. Similar findings are reported in other studies (King and Levine, 1993; Pasiouras et al., 2009; Lozano-Vivas and Pasiouras, 2010). The reason for improving the cost efficiency and reducing profit efficiency is the same as that posited by VanHoose (2007), who concludes that long-term high capital requirements would increase the capital ratio, decreasing the probability of financial distress: on one hand, it reduces the risk premium, reducing costs; on the other hand, as Keeley and Furlong (1990) suggest, high capital requirements reduce the incentive of the risk factor choice, increasing substitutions for higher return investments, thus reducing profit efficiency.

The variable of supervisory power (*SUP*) has a statistically significant and positive impact on cost inefficiency but negative impact on profit inefficiency. Therefore, high official power supervisory reduces cost efficiency, but improves profit efficiency. The finding for the cost efficiency seems to support the argument that strong power of supervision could lead to inefficiency of banks (Quintyn and Taylor, 2003). While the positive for profit efficiency is supported by the official supervisory approach that argues that a powerful supervisory approach would directly improve bank efficiency through market competition (Barth et al., 2006).

The variable of private monitoring (*PRIM*) is statistically significant and positively related to cost and profit inefficiency. It implies that higher private monitoring reduces bank cost and profit efficiency. This finding is in contrast to the previous research (e.g. Barth et al., 2004; Pasiouras et al., 2009) which suggests that a high level of private monitoring might improve bank efficiency.

The variable of activity restrictions (*ACT*) is statistically significantly and negatively related to cost inefficiency, but positive related profit inefficiency. It is confirmed by (Barth et al., 2004; Lozano-Vivas and Pasiouras, 2010) which suggests that less regulatory restrictions on the activities of banks gives banks more opportunities to engage in diversified activities and gain a more profitable portfolio, improving profit efficiency. The reduction of cost efficiency can be explained by management costs increasing for such diversified bank activities.

5.3.2.5 Effect of market structure and macroeconomic variables

Turning to other control variables, the two market structure variables are captured using the ratio of private sector claims to the banking sector over GDP (*CLAIM*) and the share of the three largest bank as a measure of Concentration (*CONC*). The results show that *CONC* is highly significant and negatively related to cost inefficiency in all specifications, while positively related to profit inefficiency in column 4 and 5 but negatively related to profit inefficiency in column 6. Thus, higher concentration unambiguously improves the cost efficiency, while the impact on profit efficiency is mixed dependent on the measure of liberalisation used. Generally, the improvement of cost efficiency results from the consolidation of less efficient banks, with the survival of

more efficient banks decreasing average costs, thereby improving bank cost efficiency. While concentration is usually represented as a measure of market power, its effect on reducing profit efficiency (columns 4 and 5) can be explained by the quiet life hypothesis (Hicks, 1935) which suggests that higher concentration reduces competition, so that less competitive pressure leads bank managers to not chase maximum profit efficiency, so the on profit inefficiency is positive. *CLAIM* is generally used as a proxy for financial development, with the results showing a similarly mixed impact on cost and profit efficiency depending on the measure of liberalisation used. For example, on the de jure measure, higher levels of financial development results in greater cost efficiency, but lower profit efficiency, whereas *CLAIM* is positively related to both cost and profit inefficiency when the de facto measure of financial liberalisation is used. This result is partially consistent with Pasiouras et al. (2009) who explain that lower profit efficiency might result from firms being less reliant on bank financing, since the higher development of financial markets provides the choice to finance via equity markets (Demirgüç-Kunt and Huizinga, 1999).

The macroeconomic environment variables used are real GDP growth (*GDPGR*) and inflation (*INFA*). The effect of *GDPGR* is statistically significant and negatively related to both cost and profit inefficiency in most of the specifications. The result implies that a higher GDP growth rate improves bank efficiency. This finding is consistent with Yildirim and Philippatos (2007) and Pasiouras et al. (2009). *INFA* is statistically significant and positively related to cost inefficiency but negatively related to profit inefficiency in all the specifications. The result implies that a higher inflation rate reduces cost efficiency, but increases profit efficiency. The reason for reduced cost efficiency might be that banks adjust their interest rates in response to higher inflation; however, if the interest rate increase is in the predicted range, banks may adjust their interest rates further to increase revenues more than costs, so profitability increases (Perry, 1992; Athanasoglou et al., 2008).

5.3.2.6 Effect of the financial crisis: dummy variables

Regarding the financial crisis dummy variable (*FC*), the results indicate that the financial crisis is statistically significant and positively related to cost and profit

inefficiency. This implies that the financial crisis has a negative influence on both cost and profit efficiency. The results are partially consistent with our basic efficiency score analysis, with sharply declining profit efficiency from 2007 to 2009, with the external shock of the global financial crisis consistent with the study of Vu and Turnell (2011) in Australia.

5.4 Robustness analysis

5.4.1 Regional specific frontiers

This section uses separate frontiers for the different income groups of countries, for two main reasons: firstly, the common (global) frontier analysis makes the assumption that all banks in different countries produce via the same technology. Hence, the global frontier analysis does not reflect the cross-regional or cross-country differences. Therefore, using separate frontiers captures the different production technology across different levels of economic development. Secondly, it has been argued that the impact of financial liberalisation on financial development or on macroeconomic development depends on the initial level of economic development, financial market development and the different qualities of the institutions in the various countries (Broner and Ventura, 2010). For example, Dietsch and Lozano-Vivas (2000) indicate that cross-country differences in per capita income and population density have a significant impact on the demand for bank products and services. Maghyereh (2004) suggests that the different economic environments across countries would lead to the differences in bank efficiency. In view of these considerations, this section discusses the impact of financial liberalisation on bank cost and profit efficiency by splitting the sample countries into four levels of income groups and check for the robustness of the results to capture the effects across different levels of economic development.

Focussing solely on the impact of capital market liberalisation (using the de jure and de facto measures only), Table 5-4 and Table 5-5 show the effects on cost and profit inefficiency across the different income-groups (high, upper-middle, lower-middle and lower). Comparing with the results of the common frontier in Table 5-3, the regional frontier results show that for high-income and upper-middle income group countries, both measures of financial liberalisation (in all columns except one) are statistically significant and negatively related to cost and profit inefficiency, implying that financial liberalisation

actually improves both cost efficiency and profit efficiency in the high and upper-middle income group countries. One possible explanation is that high and upper-middle income group countries have more developed financial markets, and banks in these regions have better experience and advanced management skills for complex international financial markets. Thus, financial liberalisation in high and upper-middle income group countries gives banks better opportunities to exploit resources, gain diversified portfolios and improve their cost and profit efficiency.

Concerning lower-middle and lower income group countries, the results show that financial liberalisation (in most of the columns) has a positive impact on both cost and profit inefficiency, implying that higher financial liberalisation reduces bank efficiency in these regions. However, for the lower income group countries, the impact is insignificant in most cases. One possible explanation is that in lower-middle and lower income countries have less developed financial markets and liberalisation would induce costs associated with advanced technology and management skills into these countries thus lowering cost efficiency. Furthermore, lower profit efficiency of banks in middle-lower income group countries may be due to lack of experience in risk management. Evidence shows that regulatory weaknesses in emerging markets are often trigger for financial crises that are harmful to banks' profitability (Bird and Rajan, 2001). The link between financial liberalisation and financial crises, especially in the banking sector of emerging markets, has been confirmed by Daniel and Jones (2007) and Angkinand et al. (2010).

Table 5-4 Potential determinants on cost inefficiencies (Regional frontiers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.1765	-1.3560***	-1.4088***	0.7081***	-4.7792***	-1.4893***	-0.4339***	-0.5908
	(0.1191)	(0.5611)	(0.0226)	(0.3425)	(1.4700)	(0.0100)	(0.0002)	(0.5640)
CHIN (De jure)	-0.0218***	-0.0355***	0.2748***	-0.0459				
	(0.0061)	(0.0147)	(0.0516)	(0.0363)				
FINLIB (De facto)					0.0646***	-0.1710***	0.1832***	0.4901***
					(0.0198)	(0.0100)	(0.0003)	(0.1132)
CAPR	0.0031	-0.0315***	-0.1961***	-0.0137	0.3782***	-0.1831***	-0.0742***	0.0718***
	(0.0020)	(0.0130)	(0.0575)	(0.0160)	(0.1161)	(0.0043)	(0.0000)	(0.0289)
SUP	0.0031***	0.0353***	-0.0025	0.0329***	0.0094***	-0.0808***	0.0194***	0.0275***
	(0.0013)	(0.0146)	(0.2483)	(0.0151)	(0.0028)	(0.0086)	(0.0000)	(0.0130)
PRIM	0.0185***	0.0081***	0.2898*	0.0818***	0.8391***	-0.0426***	0.0444***	0.0257
	(0.0045)	(0.0032)	(0.1725)	(0.0242)	(0.2583)	(0.0095)	(0.0001)	(0.0251)
ACT	-0.0507***	0.0476***	-0.4708***	-0.4863***	-2.6886***	-0.0166*	-0.0349***	-0.2628***
	(0.0068)	(0.0198)	(0.0359)	(0.0843)	(0.8237)	(0.0099)	(0.0003)	(0.0977)
CONC	-0.0114	0.3093***	-0.9982***	0.5615***	-9.6564***	0.2316***	-0.4924***	0.6878***
	(0.0229)	(0.1284)	(0.0192)	(0.1776)	(2.9668)	(0.0100)	(0.0011)	(0.3304)
CLAIM	-0.0589***	0.1577***	-0.5111***	-2.2516***	-1.6805***	0.2779***	-0.2479***	-1.5477***
	(0.0106)	(0.0655)	(0.0120)	(0.4587)	(0.5150)	(0.0100)	(0.0047)	(0.7175)
GDPGR	0.0021	-0.0041***	-0.1253***	-0.0053	0.1768***	-0.0669***	0.0589***	-0.0059
	(0.0015)	(0.0017)	(0.0283)	(0.0047)	(0.0540)	(0.0095)	(0.0001)	(0.0054)
INFA	0.0068***	0.0091***	-0.2848***	-0.0048	0.1518***	0.0428***	-0.0319***	-0.0110***
	(0.0024)	(0.0038)	(0.0793)	(0.0035)	(0.0461)	(0.0170)	(0.0000)	(0.0053)
FC	0.0014	-0.0137***	-5.2356***	0.1058	0.9690***	-0.0404***	-3.1616***	0.0084
	(0.0122)	(0.0057)	(0.0101)	(0.1417)	(0.2983)	(0.0100)	(0.0073)	(0.1452)

Note: column (1) & (5) refer to the high income economies; column (2) & (6) refer to the upper-middle income economies; column (3) & (7) refer to the middle-lower income economies; column (4) & (8) refer to the lower income economies. Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level.

Table 5-5 Potential determinants on profit inefficiencies (Regional frontiers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	-2.4451***	-4.1793	-12.8390	-2.8459	-3.1246***	-4.9158	-0.4187*	-4.0248*
	(0.6215)	(2.5976)	(16.5190)	(4.0770)	(1.1063)	(4.6649)	(0.2280)	(2.0627)
CHIN (De jure)	-0.2602***	-0.0102***	0.9696	0.0707				
	(0.0494)	(0.0049)	(1.2465)	(0.1094)				
FINLIB (De facto)					-0.1682***	-0.9996	0.1740*	0.2938
					(0.0586)	(0.8962)	(0.1049)	(0.4098)
CAPR	0.0249***	0.0479	0.6375	-0.0343	-0.1515***	0.2117	-0.0225	-0.0617
	(0.0049)	(0.0293)	(0.7872)	(0.0483)	(0.0528)	(0.1932)	(0.0144)	(0.0932)
SUP	-0.0773***	-0.0562	0.5194	0.0478	-0.0703***	-0.2253	0.0088*	0.2075***
	(0.0140)	(0.0345)	(0.6962)	(0.0674)	(0.0244)	(0.2088)	(0.0050)	(0.0606)
PRIM	0.1172***	0.2450	0.0178	0.1064	0.1321***	1.0445	0.0137	0.2901***
	(0.0428)	(0.1544)	(0.1154)	(0.1536)	(0.0474)	(0.9267)	(0.0086)	(0.1251)
ACT	0.1464***	0.4792	-0.9628	-0.3748	-0.6612***	0.2912	0.1137	-0.4137
	(0.0295)	(0.3014)	(1.2316)	(0.5493)	(0.2293)	(0.2392)	(0.0692)	(0.2959)
CONC	0.6834***	0.8702*	-0.4588	1.8927	1.9877***	-3.9177	-0.8065*	2.7679***
	(0.1334)	(0.5188)	(0.9050)	(2.7383)	(0.6910)	(3.5444)	(-0.4837)	(1.0796)
CLAIM	0.2300***	-0.8868	6.0038	1.2589	0.7429***	-3.2685	-0.0225	-0.1531
	(0.0548)	(0.5577)	(7.4765)	(1.8305)	(0.2609)	(3.0777)	(0.0498)	(2.5009)
GDPGR	-0.1505***	-0.0976	-0.2376	0.0458	-0.3439***	-0.0615	-0.0040*	-0.0149*
	(0.0287)	(0.0599)	(0.2610)	(0.0659)	(0.1197)	(0.0526)	(0.0022)	(0.0228)
INFA	-0.0117*	-0.0234	-0.0950	0.0275	0.1611***	0.0004	-0.0131	-0.0250
	(0.0066)	(0.0145)	(0.0028)	(0.0386)	(0.0565)	(0.0035)	(0.0083)	(0.0206)
FC	0.4122***	0.2672	1.3634	0.1702	-2.3439***	1.1931	0.0311	-0.1589
	(0.0867)	(0.1791)	(1.8214)	(0.2472)	(0.8173)	(1.1326)	(0.0400)	(0.6948)

Note: column (1) & (5) refer to the high income economies; column (2) & (6) refer to the upper-middle income economies; column (3) & (7) refer to the middle-lower income economies; column (4) & (8) refer to the lower income economies. Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level.

5.4.2 Traditional intermediation approach

This section analyses the impact of financial liberalisation on bank cost and profit efficiency using the traditional intermediation approach with only two outputs: loans (Q_1) and other earning assets (Q_2). The analysis in previous section included a third output variable: non-interest income (Q3) as a proxy for off-balance sheet income. Some studies have followed the traditional approach of excluding the off-balance sheet activities or non-interest income to estimate bank efficiency (Lensink et al., 2008). Table 5-6 presents the results on cost and profit inefficiency on the basis of a traditional intermediation approach. The results using the global frontier show that the impact of financial liberalisation on cost and profit efficiency is consistent with the earlier results when including non-traditional activities: (i) both *de jure* and *de facto* measures are positively related to profit efficiency; (ii) the *de jure* measure negatively influences cost efficiency; and (iii) the *je facto* measure positively relates to profit efficiency.

5.4.3 Assessing the impact of different crises

The empirical results shown in Table 5-7 highlight the significant impact of financial liberalisation on bank cost and profit efficiency when considering for the separate influence of banking, currency and sovereign crises. The results are consistent with the earlier results. Additionally, Table 5-7 shows the banking crisis dummy variable is statistically significant and positively related to cost inefficiency. However, the results show the relationship between profit inefficiency and banking crisis dummy varies with the measure of financial liberalisation, being positive under *de jure* and negative under *de facto*.

Table 5-6 Determinants of cost and profit inefficiency (Traditional intermediation approach)

	Cost inefficiency		Profit inefficiency	
	(1)	(2)	(3)	(4)
Constant	-14.2850***	-7.9439***	-5.6303***	-4.7278***
	(3.0681)	(1.6908)	(1.2456)	(1.6719)
FINLIB	0.3586***	-0.0360***	-0.0657***	-0.0978***
	(0.0771)	(0.0080)	(0.0152)	(0.0343)
CAPR	-0.8649***	-0.4686***	0.0557***	0.0115***
	(0.1854)	(0.0989)	(0.0123)	(0.0042)
SUP	0.4397***	0.2505***	-0.0631***	-0.0242***
	(0.0944)	(0.0530)	(0.0137)	(0.0086)
PRIM	0.7828***	0.4880***	0.1120***	0.2657***
	(0.1679)	(0.1037)	(0.0240)	(0.0939)
ACT	-1.3512***	-0.4995***	0.3580***	-0.0928***
	(0.2898)	(0.1044)	(0.0806)	(0.0327)
CONC	-7.4890***	-5.8998***	1.0154***	0.0299***
	(1.6064)	(1.2404)	(0.2295)	(0.0106)
CLAIM	-2.1233***	-0.4731***	0.1166***	0.1482***
	(0.4551)	(0.0973)	(0.0226)	(0.0518)
GDPGR	-0.0082***	-0.0001***	-0.1560***	-0.1348***
	(0.0018)	(0.0000)	(0.0343)	(0.0477)
INFA	0.1907***	0.1122***	-0.0130***	-0.0069***
	(0.0409)	(0.0237)	(0.0029)	(0.0024)
HIGH	4.6674***	2.5233***	1.2933***	0.9621***
	(1.0006)	(0.5342)	(0.2907)	(0.3388)
UPPH	2.6013***	0.8686***	1.0666***	1.0296***
	(0.5588)	(0.1850)	(0.2364)	(0.3633)
LOWMID	6.9149***	3.4231***	0.8231***	-0.1137***
	(1.4838)	(0.7239)	(0.1805)	(0.0397)
FC	1.7535***	1.2497***	0.4250***	0.5001***
	(0.3760)	(0.2722)	(0.0971)	(0.1745)

Note: Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level. For the time limitation of the database of IMF (*de facto*) financial liberalisation measures, the third and fourth columns are the estimation from 2000 to 2007. The first and second columns are the estimation for the time period from 2000 to 2009, with the Chinn-Ito (*de jure*) financial liberalisation measure.

Table 5-7 Determinants of cost and profit inefficiency (Controlling for the crisis dummies)

	Cost inefficiency		Profit inefficiency	
	(1)	(2)	(3)	(4)
Constant	-11.7250**	-12.9060***	-6.85760***	-4.5274***
	(3.5932)	(5.4777)	(1.4503)	(0.6647)
FINLIB	0.3448**	-0.1210***	-0.07267***	-0.0751***
	(0.1049)	(0.0512)	(0.0158)	(0.0109)
CAPR	-0.5852**	-0.5854***	0.06214***	0.0181***
	(0.1800)	(0.2481)	(0.0129)	(0.0027)
SUP	0.2334**	0.2330***	-0.07558***	-0.0304***
	(0.0718)	(0.0992)	(0.0154)	(0.0045)
PRIM	0.6187**	0.8788***	0.12426***	0.2568***
	(0.1899)	(0.3714)	(0.0258)	(0.0377)
ACT	-0.8467**	-0.4835***	0.45393***	-0.1043***
	(0.2605)	(0.2046)	(0.0988)	(0.0153)
CONC	-4.5156**	-6.5641***	1.33550***	-0.0311***
	(1.3894)	(2.7827)	(0.2803)	(0.0061)
CLAIM	-0.5980***	0.2675***	0.12222***	0.1592***
	(0.1806)	(0.1159)	(0.0258)	(0.0229)
GDPGR	0.0072**	0.0014***	-0.18738***	-0.1281***
	(0.0023)	(0.0007)	(0.0390)	(0.0189)
INFA	0.1190**	0.1225***	-0.00417***	0.0108***
	(0.0366)	(0.0521)	(0.0011)	(0.0017)
HIGH	1.5200**	2.3397***	1.63170***	0.9074***
	(0.4659)	(0.9937)	(0.3461)	(0.1333)
UPPH	2.4661**	2.1374***	1.24510***	0.9130***
	(0.7527)	(0.9053)	(0.2594)	(0.1342)
LOWMID	4.0894**	4.3358***	0.94698***	-0.1621***
	(1.2524)	(1.8398)	(0.1960)	(0.0231)
BC	0.3031***	1.8217***	0.48655***	-0.1833***
	(0.0899)	(0.7690)	(0.1055)	(0.0268)
CC	2.8973**	2.7254***	-0.91327***	-0.7668***
	(0.8828)	(1.1592)	(0.1544)	(0.1223)
SC	-1.1083***	-2.1317***	1.28610***	1.3687***
	(0.3245)	(0.8968)	(0.2668)	(0.1983)

Note: Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level. Column 1 and 3 are using de jure measure; Column 2 and 4 are using de facto measure. BC is the systemic banking crisis dummy, which assumes the value 1 in the first year that the bank crisis occurs, and 0 if there is no crisis. CC is the currency crisis dummy and SC is the sovereign crisis.

5.4.4 Assessing the impact of leverage ratio

This section extends the robustness analysis by adding the leverage ratio as an inefficiency variable, for the following reasons: firstly, it had been argued that the choice of capital structure should be taken into account when modelling bank production that relates to bank performance (Hughes and Mester, 2008). With regard to the banking sector, the leverage ratio is generally defined as Tier 1 capital (equity and other disclosed equity reserves) over total adjusted assets (total assets minus intangible assets), but there is very limited data available in the database of Bankscope to allow it to be included. An alternative measure is to simply use the ratio of total equity over total assets as the leverage ratio. The results, shown in Table 5-8, confirm that the significant impact of financial liberalisation on bank cost and profit efficiency is consistent with previous results. The results also show that the leverage ratio has a positive impact on profit inefficiency, consistent with (Fiordelisi et al., 2011), implying a negative impact on profit efficiency. However, the result shows that the relationship between leverage ratio and cost inefficiency varies with the measure of financial liberalisation, being negative under *de jure* and positive under *de facto*.

Table 5-8 Determinants of cost and profit inefficiency (Controlling leverage ratio)

	CHIN (*de jure*) financial liberalisation		IMF (*de facto*) financial liberalisation	
	Cost inefficiency	**Profit inefficiency**	**Cost inefficiency**	**Profit inefficiency**
Constant	-0.5086***	-2.4166***	-1.3903***	-2.9134***
	(0.0814)	(0.7261)	(0.5261)	(0.3754)
FINLIB	0.0109***	-0.0179***	-0.0147***	-0.0466***
	(0.0052)	(0.0054)	(0.0055)	(0.0059)
CAPR	-0.0106***	0.0219***	-0.0705***	0.0096***
	(0.0040)	(0.0067)	(0.0266)	(0.0013)
SUP	0.0008	-0.0233***	0.0223***	-0.0204***
	(0.0030)	(0.0058)	(0.0084)	(0.0026)
PRIM	-0.0313***	0.0491***	0.0924***	0.1707***
	(0.0074)	(0.0159)	(0.0349)	(0.0221)
ACT	0.0341***	0.1681***	-0.0472***	-0.0537***
	(0.0118)	(0.0520)	(0.0178)	(0.0067)
CONC	0.0672*	0.4118***	-0.7652***	-0.2244***
	(0.0381)	(0.1093)	(0.2892)	(0.0288)
CLAIM	0.1617***	0.0623***	0.0355***	0.0951***
	(0.0223)	(0.0213)	(0.0135)	(0.0122)
GDPGR	-0.0002	-0.0597***	0.0004***	-0.0862***
	(0.0016)	(0.0171)	(0.0002)	(0.0111)
INFA	0.0037***	-0.0066***	0.0128***	-0.0040***
	(0.0010)	(-0.0017)	(0.0048)	(0.0005)
HIGH	-0.1634***	0.4252***	0.2439***	0.4290***
	(0.0541)	(0.1246)	(0.0922)	(0.0540)
UPPH	0.9379***	0.3008***	0.1642***	0.4725***
	(0.0643)	(0.0842)	(0.0620)	(0.0595)
LOWMID	0.4081***	0.2282***	0.4593***	-0.2179***
	(0.0607)	(0.0627)	(0.1736)	(0.0281)
FC	-0.0066	0.1565***	0.1847***	0.0153***
	(0.0316)	(0.0425)	(0.0698)	(0.0015)
E/A	-0.8312***	1.2685***	1.0288***	1.6758***
	(0.1198)	(0.3497)	(0.3901)	(0.2186)

Note: Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level.

5.5 Conclusion

This chapter has presented comprehensive cross-country evidence about the impact of financial liberalisation on the cost and profit efficiency of banks using stochastic frontier analysis. The Battese and Coelli (1995) model was employed to allow

for the estimation of bank efficiency in a one-step modelling approach to simultaneously incorporate the effect of various bank specific and country-specific controls. The empirical analysis was conducted using a global frontier as well as region specific frontiers to account for different levels of economic development.

The results indicate that profit efficiency is positively and significantly influenced by financial liberalisation, implying that the higher the extent of financial liberalisation the greater profit efficiency of banks. On the other hand, the evidence seems to suggest that the directional impact on bank cost efficiency, while statistically significant, depends on the measure of liberalisation used. Furthermore, while cost efficiency remains, on average, stable during the estimation period, average profit efficiency declines sharply in the post crises period (2007-09). Furthermore, we also control for the financial crises dummy, and the findings suggest that financial crises that refers to banking, currency and sovereign crises, on average, has a negative effect on both cost and profit efficiency of banks. This finding is partly consistent with the sharply downward trend of profit efficiency in the post-crises period.

Furthermore, this chapter investigates in greater detail the impact of different dimensions of financial liberalisation on the cost and profit efficiency of banks. The results, in general, show that the greater liberalisation of capital controls and equity markets, the more significant the impact on cost and profit efficiency. However, entry barrier and interest rate liberalisation have a negative impact on cost and profit efficiency. In contrast, privatization and capital account liberalisation have a negative impact on cost efficiency, but tend to improve the profit efficiency of banks.

As part of robustness, this chapter also estimated cost and profit efficiency using region specific frontiers associated with different income-group of counties, as classified (according to the World Bank) into four income groups (high, upper-middle, lower-middle, and lower) to account for different levels of economic development. The results show that the effect on banks' cost and profit efficiency is more pronounced and positive in the high-income and upper-middle income countries, while it is significant but negatively in the middle-low income group countries. By contrast, the results are not statistically significant in the lower-income group countries. In general, this part of the empirical evidence appears to support the view, in line with previous studies that analyses

the effects of financial liberalisation on economic growth that the overall impact on cost and efficiency across different counties and regions of the world varies with the level of economic development.

Appendix 5.A

Table 5.A.1 Summary Statistics of the Variables

Dependent Variables	Description	Obs	Mean	St.dev	Min	Max
TC	Total Cost	10907	729.162	4163.821	0.122	116054.500
PBT	Profit Before Tax	10907	116.803	726.498	-13212.070	14002.290
Independent Variables						
Input Variables						
W1	Cost of Loanable Funds	10907	0.057	0.165	0.000	10.000
W2	Cost of Physical Capital	10907	2.721	9.896	0.024	417.000
W3	Cost of Labour	10907	0.017	0.015	0.000	0.172
Output Variables						
Q1	Loan	10907	8032.143	42756.240	0.053	843425.200
Q2	Other Earning Assets	10907	8307.970	61523.680	0.065	1658233.000
Q2	Non-interest Income	10907	214.805	1329.198	0.018	31227.400
Quasi-Fixed Input Variable						
E	Equity	10907	831.396	4151.546	0.281	92225.500
Potential Correlation Variables						
CHIN	Financial Liberalisation	10907	1.1846	1.462068	-1.85564	2.45573
Bank-Specific Variable						
CLAIMS	Claims to Private Sector	10907	0.7460664	0.5383038	0.0394596	2.436411
CONC	Bank Concentration	10907	0.6230588	0.1825779	0.2116347	1
Country-Specific Variable						
Macroeconomic Condition						
GDPGR	GDP Growth Rate	10907	3.436289	3.815888	-17.7	21.2
INFA	Inflation Rate	10907	4.897139	5.580754	-10.4	54.9
Regulatory & Supervisory						
	Capital Requirement	10907	5.207023	1.673149	1	8
SUP	Power of Supervision	10907	10.72366	2.597646	4	15
PRIM	Private Monitoring	10907	6.037591	0.9273336	3	8
ACT	Restriction on Bank Activities	10907	2.378541	0.6874831	1	4
Degree of Development						

HIGH	High Income	10907	0.4927111	0.4999698	0	1
UPPH	Upper Middle Income	10907	0.267718	0.4427901	0	1
LOWMID	Lower Middle Income	10907	0.1932704	0.3948813	0	1
Financial Crisis Dummy						
FC	Financial Crisis Dummy	10907	0.0551022	0.2281902	0	1

Source: Variable of CHIN is obtained from 2010 version of Chin-Ito Database. Macroeconomic variables are available from Global Market Information Database (GMID); Regulatory & Supervisory Variables are obtained from database of Barth et al. (2002, 2003, and 2007); Degree of Development Variables are obtained from World Bank Database. Note: Variables of TC, PBT,Q1,Q2,Q3 and E are expressed by US millions dollars and adjusted by the deflator in real 1995 term.

Table 5.A.2 Description of the variables

Variable	Description	Source
International Financial Liberalisation		
FINLIB (*de jure*) indictor of financial liberalisation	Chinn-Ito index measures the intensity of the openness of capital account transaction that was constructed from the IMF' annual report (International Monetary Fund) on *Exchange Arrangements and Exchange Restrictions* (AREAER). The indictor was constructed by the dummy variables for four major restrictions categories: (i) the presence of multiple exchange rates;(ii) restrictions on current account transactions; (iii) restrictions on capital account transactions; (iiii) the requirement of the surrender of export proceeds. The variable equals 1 when the restriction is not existed, otherwise equals 0. Moreover, the third categories of the controls on capital transitions, they use the share of a five-year window and incorporate other three variables. The higher value of the index the more openness of countries' capital account.	Chinn, M. D. and Ito, H. (2008) 'A New Measure of Financial Openness'. Journal of Comparative Policy Analysis: Research and Practice 10 (3), 309-322. Note this paper uses the 2010 version of the database. Available from: http://web.pdx.edu/~ito/Chinn-Ito_website.htm. [Accessed on 9th Sep,2012]
FINLIB (*de facto*) indictor of financial liberalisation	The ratio of sum of the gross stocks of foreign assets and liability to GDP	Kose, M. A., Prasad, E., Rogoff, K., and Wei, S. J. (2009) 'Financial Globalization: A Reappraisal'. IMF Staff Papers 56 (1), 8-62
Entry Barrier Liberalisation (ENTRY)	Elimination of entry barriers. This variable scores 0–3, which is determined by the following questions: (1) To what extent does the government allow foreign banks to enter into a domestic market? (2) Does the government allow the entry of new domestic banks (3) have the government eased branching restrictions?	Abiad, Abdul, Enrica Detragiache, and Thierry Tressel, "A New Database of Financial Reforms," IMF Working Paper WP/08/266, December 2008 (http://www.imf.org/external/pubs/cat/longres.cfm

Capital Account Liberalisation (CAPITAL)	Elimination of capital account restrictions. This variable scores 0–3, which is determined by the following three questions: (1) Is the exchange rate system unified? (2) Does a country set restrictions on capital inflow? (3) Does a country set restrictions on capital outflow? (yes 51; no 50)	?sk=22485.0).
Equity Market Liberalisation (EQUITY)	The liberalisation of security market policy. This variable scores 0–3, which is determined by the following questions: (1) Has a country taken measures to develop security market? (2) Is a country's equity market open to foreign investors? (the answers for each question have a scale of 0–2)	
Domestic Financial Liberalisation		
Credit Control Liberalisation (CREDIT)	Elimination of credit controls and excessively high reserve requirements. This variable scores 0–3, which is determined by the following questions: (1) Are reserve requirements restrictive? (2) Are there minimum amounts of credit that must be channelled to certain sectors? Or are there ceilings on credit to other sectors? (3) Are there any credits supplied to certain sectors at subsidized rates? (yes 51; no 50)	Abiad, Abdul, Enrica Detragiache, and Thierry Tressel, "A New Database of Financial Reforms," IMF Working Paper WP/08/266, December 2008 (http://www.imf.org/external/pubs/cat/longres.cfm ?sk=22485.0).
Interest Rate Liberalisation (INTRA)	Elimination of interest rate controls. This variable scores 0–3, which is determined by the following three questions: (1) Are interest rates subject to ceilings/floors or determined by the central bank? (2) Are interest rates allowed to float within a band or are partially liberalized? (3) Are interest rates determined at market rates?	
Privatization (PRIVATI)	Reduction in state ownership of the banking sector. This variable scores 0–3, which is determined by the percentage of the state ownership of banks (privatization 53 if state ownership of banks is less than 10% and privatization 50 if state ownership of banks is greater than 50%)	
Regulatory and Supervisory Variables		
Capital requirements (*CAPR*)	It is calculated by adding 1 if answer is yes to question 1-6 and 0 to each no question. Question 7-8 by adding 0 to no and 1 otherwise. (1) Is the minimum required capital asset ratio risk-weighted in line with Basle guidelines? (2) Does the ratio vary with market risk? (3–5) Before minimum capital adequacy is determined, which of the following are deducted from the book value of capital: (a) market value of loan losses not realized in accounting books? (b) Unrealized losses in securities portfolios? (c) Unrealized foreign exchange losses? (6) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (7) Can the initial or subsequent injections of capital be done with assets other than cash or government securities? (8) Can initial disbursement of capital be done with borrowed funds?	The regulation and supervision of banks around the world - a new database, by James R. Barth, Gerard io, Jr. and Ross Levine. World Bank Policy Research Working Paper Number 2588, April 2001. Note this paper use the 2001, 2003, 2007, three versions of the database, followed the Pasiouras et al. (2009) the way of calculation. Available from: http://econ.worldbank.org/. [Accessed on 9th Sep,2012]

Official supervisory power (*SUP*)	It is calculated by adding 1 if answer is yes and 0 to each no questions followed for fourteen questions: This variable is determined by adding 1 if the answer is yes and 0 otherwise, for each one of the following fourteen questions: (1) Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank? (2) Are auditors required by law to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in illicit activities, fraud, or insider abuse? (3) Can supervisors take legal action against external auditors for negligence? (4) Can the supervisory authorities force a bank to change its internal organizational structure? (5) Are off-balance sheet items disclosed to supervisors? (6) Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? (7) Can the supervisory agency suspend director's decision to distribute dividends? (8) Can the supervisory agency suspend director's decision to distribute bonuses? (9) Can the supervisory agency suspend director's decision to distribute management fees? (10) Can the supervisory agency supersede bank shareholder rights and declare bank insolvent? (11) Does banking law allow supervisory agency or any other government agency (other than court) to suspend some or all ownership rights of a problem bank? (12) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency (other than court) supersede shareholder rights? (13) Regarding bank restructuring and reorganization, can supervisory agency or any other government agency (other than court) remove and replace management? (14) Regarding bank restructuring and reorganization, can supervisory agency or any other government agency (other than court) remove and replace directors?	
Private monitoring (*PRIM*)	It is calculated by adding 1 if answer is yes to question 1-6 and 0 to each no question. Question 7-8 by adding 0 to no and 1 otherwise. This variable is determined by adding 1 if the answer is yes to questions 1–6 and 0 otherwise, while the opposite occurs in the case of questions 7 and 8 (i.e. yes = 0, no = 1). (1) Is subordinated debt allowable (or required) as part of capital? (2) Are financial institutions required to produce consolidated accounts covering all bank and any non-bank financial subsidiaries? (3) Are off-balance sheet items disclosed to public? (4) Must banks disclose their risk management procedures to public? (5) Are directors legally liable for erroneous/misleading information? (6) Do regulations require credit ratings for commercial banks? (7) Does accrued, though unpaid interest/principal enters the income statement while loan is non-performing? (8) Is there an explicit deposit insurance protection system?	
Bank activities restrictiveness	This indicator represents the degree of bank engage in the: (1) securities activities (2) insurance activities (3) real estate activities (4) bank ownership of non-financial firms. These activities can be unrestricted, permitted; restricted or prohibited these are assigned	

(*ACT*)	the values of 1, 2, 3 or 4, respectively. Then we calculate the average score of the four restrictions.	
Market Structure and Financial Development Variables		
bank concentration (*CONC*)	Assets of three largest banks as a share of assets of all commercial banks	Thortsen Beck and Asli Demirgüç-Kunt, "Financial Institutions and Markets Across Countries and over Time: Data and Analysis", World Bank Policy Research Working Paper No. 4943, May 2009. Note this paper uses the 2010 version of the database. Available from: http://econ.worldbank.org/. [Accessed on 9th Sep,2012]
Claims(*CLAIM*)	Private credit by deposit money banks to GDP	
Macroeconomic Variables		
GDP growth rate (*GDPGR*)	Real GDP growth rate	Global Market Information Database
Inflation rate (*INFA*)	Annual inflation rate	Global Market Information Database
Country Income-Group Variables		
High Income	The variable equals 1, when the country belongs to the high income group, otherwise 0.	World Bank database
Upper and Middle Income	The variable equals 1, when the country belongs to the Upper and Middle Income group, otherwise 0.	World Bank database
Middle and Lower Income	The variable equals 1, when the country belongs to the Middle and Lower Income group, otherwise 0.	World Bank database
Financial Crisis Dummy		
Financial Crisis Dummy (*FC*)	The variable equals 1, crisis happen, otherwise 0.	Laeven and Valencia, 2012

Appendix 5.B

Comparing the profit efficiency distribution between two transformation ways (the negative profit before tax)

In the profit frontier model, we use profit before tax as the dependent variable in the function. When the dependent variable of profit before tax is transformed to the natural logarithm, this transformation requires the variable to be the positive number. Some of the previous studies, e.g. Berger and Mester (1997), Pasiouras et al. (2009), followed to add a constant value to solve the non-positive value of profit before tax, the absolute value of minimum profit before tax plus one and add to original value: PBT+ (| PBT^{min}|+1). In such a way, each value of profit before tax is positive. However, Bos and Kotter (2011) argue that such transformation might affect the error term which is an important aspect of stochastic frontier analysis and also might lead to the omit information from the truncated part distribution of the dependent variable. They suggest the prior transformation way would lead to the profit efficiency locates closet to the full efficiency frontier that might due to the unadjusted output quantity and input price and lead to the efficiency estimation bias. They introduce that the dependent variable assigned value of 1 when PBT $\leq$ 0, then, the additional independent variable (negative profit indicator: *NPI*) equals 1 when PBT $\geq$ 0 and equals absolute value of PBT for the losing banks, is that it include all the information of profit before tax and outliers do not bias efficiency (Bos and Kotter, 2011).

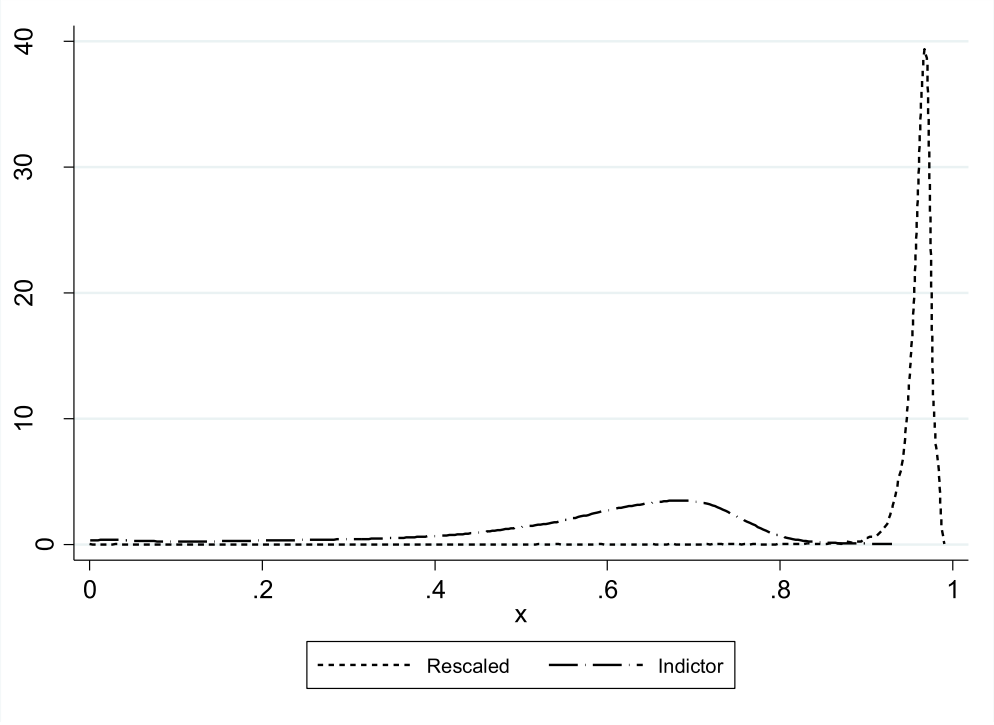

Figure 1 kernel density of the profit efficiency per specification

Figure 1 show the kernel density plots of the profit efficiency that is on the basis of our sample banks. Rescale refers to transform the negative value of profit before tax followed by the PBT+ (| PBT^{min}|+1). Indictor refers to transform the loss followed by Bos and Kotter, (2011). It shows the plot of rescaled, profit efficiency of the individual bank is closet the full efficiency frontier and with lower SD. This finding is confirmed by Bos and Kotter (2011).

We are focus on discussing the effects of financial liberalisation on the bank efficiency, Table 1 shows that the financial liberalisation statistical significant and negative relates to the profit inefficiency for both rescale and indicator ways. In both specifications, evidence seems to suggest financial liberalisation positively relates to the profit efficiency.

Table 1 Determinants of profit inefficiency

	Rescale	**Indictor**
	Profit inefficiency	**Profit inefficiency**
Constant	-11.4790***	-1.6424***
	(2.5046)	(0.0644)
CHIN	-0.1248***	-0.0655***
	(0.0258)	(0.0059)
CAPR	0.1250***	0.0237***
	(0.0272)	(0.0034)
SUP	-0.1391***	-0.0864***
	(0.0295)	(0.0010)
PRIM	0.2236***	-0.0672***
	(0.0475)	(0.0058)
ACT	0.7202***	-0.2495***
	(0.1594)	(0.0068)
CONC	1.9705***	-0.4165***
	(0.4184)	(0.0331)
CLAIM	0.3071***	0.3717***
	(0.0725)	(0.0139)
GDPGR	-0.3154***	-0.0234***
	(0.0690)	(0.0017)
INFA	-0.0124***	0.0112***
	(0.0030)	(0.0014)
HIGH	2.8527***	1.9511***
	(0.6079)	(0.0395)
UPPH	2.3450***	2.2894***
	(0.5028)	(0.0232)
LOWMID	1.7810***	1.9729***
	(0.3846)	(0.0323)

Note: Standard error is reported in parentheses. ***statiscial significance at the 1% level, **statiscial significance at the 5% level, *statiscial significance at the 10%. Rescale refers to transform the negative value of profit before tax followed by the PBT+ (| PBT^{min}|+1). Indictor refers to transform the loss followed by Bos and Kotter, (2011).

The reason we employ using the transformation way that was introduced by Bos and Kotter (2011) is that it includes all the information of profit before tax and outliers do not bias efficiency (Bos and Kotter, 2011). However, as Bos and Kotter, (2011) suggest that such estimation is relative efficiency scores. There is no baseline which is validated of the efficiency scores.

Appendix 5.C

Country	Region	Income-Group	NO. of Observ.	*De Jure* FINLIB (2000 - 2009)	Min	Max	*De Facto* FINLIB (2000 - 2007)	Min	Max	GDP growth	Inflation
Albania	Eastern Europe	Lower middle income	29	-0.61	-1.16	-0.11	0.80	0.72	0.86	5.68	2.59
Algeria	Middle East and Africa	Upper middle income	61	-1.16	-1.16	-1.16	0.95	0.87	1.05	3.60	3.49
Argentina	Latin America	Upper middle income	247	-0.45	-1.16	1.40	1.87	1.27	3.13	3.80	8.16
Armenia	Asia Pacific	Lower middle income	25	2.46	2.46	2.46	1.02	0.84	1.23	6.98	4.06
Australia	Australasia	High income	68	1.13	1.13	1.13	2.36	1.69	2.58	2.89	3.04
Austria	Western Europe	High income	286	2.46	2.46	2.46	4.38	2.91	5.83	1.74	1.96
Bangladesh	Asia Pacific	Low income	128	-0.87	-1.16	2.19	0.48	0.43	0.52	6.12	5.76
Belgium	Western Europe	High income	112	2.33	1.66	2.46	7.92	5.89	10.17	1.62	2.07
Benin	Middle East and Africa	Low income	30	-1.16	-1.16	-1.16	1.05	0.73	1.30	4.23	2.95
Bolivia	Latin America	Lower middle income	64	1.25	0.61	1.40	1.54	1.27	1.78	3.68	5.02
Botswana	Middle East and Africa	Upper middle income	28	2.10	1.23	2.46	1.37	1.15	1.99	3.32	8.94
Brazil	Latin America	Upper middle income	406	0.39	-1.16	2.46	0.91	0.79	1.04	3.69	6.73
Bulgaria	Eastern Europe	Upper middle income	76	1.09	-1.16	2.46	1.83	1.48	2.41	4.46	6.55
Cameroon	Middle East and Africa	Lower middle income	52	-1.16	-1.16	-1.16	0.73	0.43	1.03	3.30	2.68
Canada	North America	High income	93	2.46	2.46	2.46	2.07	1.98	2.20	2.07	2.12
Chile	Latin America	Upper middle income	14	1.52	-1.16	2.46	1.93	1.76	2.16	3.80	3.31
Colombia	Latin America	Upper middle income	132	-0.55	-1.16	1.13	0.90	0.79	0.99	3.81	6.48
Costa Rica	Latin America	Upper middle income	113	1.22	1.22	1.22	1.06	0.87	1.26	4.36	10.86

Country	Region	Income-Group	NO. of Observ.	*De Jure* FINLIB (2000 - 2009)	Min	Max	*De Facto* FINLIB (2000 - 2007)	Min	Max	GDP growth	Inflation
Côte d'Ivoire	Middle East and Africa	Lower middle income	53	-1.16	-1.16	-1.16	1.63	1.43	1.82	0.62	3.02
Croatia	Eastern Europe	High income	215	0.82	-0.11	1.13	1.50	1.04	2.10	3.15	3.18
Cyprus	Western Europe	High income	71	1.04	-1.16	2.46	6.26	4.53	8.38	3.18	2.75
Czech Republic	Eastern Europe	High income	135	2.09	0.16	2.46	1.57	1.44	1.80	3.80	2.69
Denmark	Western Europe	High income	338	2.46	2.46	2.46	3.88	3.25	4.62	0.91	2.05
Dominican Republic	Latin America	Upper middle income	103	0.62	-1.59	1.93	0.81	0.52	1.06	5.34	13.15
Ecuador	Latin America	Upper middle income	137	1.29	-0.11	2.46	1.12	0.92	1.45	3.94	7.44
El Salvador	Latin America	Lower middle income	60	2.43	2.19	2.46	0.97	0.80	1.04	2.01	3.65
Estonia	Eastern Europe	High income	35	2.46	2.46	2.46	2.27	1.42	2.99	3.60	4.53
Ethiopia	Middle East and Africa	Low income	49	-1.16	-1.16	-1.16	0.99	0.49	1.39	8.61	12.25
Finland	Western Europe	High income	22	2.46	2.46	2.46	4.32	3.83	4.80	1.19	1.62
France	Western Europe	High income	632	2.46	2.46	2.46	4.44	3.45	5.81	1.30	1.72
Georgia	Eastern Europe	Lower middle income	48	1.30	0.71	1.40	1.03	0.89	1.22	6.24	6.49
Germany	Western Europe	High income	530	2.13	-1.16	2.46	3.31	2.73	4.12	1.86	1.78
Guatemala	Latin America	Lower middle income	24	2.40	1.22	2.46	0.73	0.65	0.76	3.45	7.11
Guyana	Latin America	Lower middle income	18	2.46	2.46	2.46	3.50	3.38	3.70	1.87	6.39
Honduras	Latin America	Lower middle income	84	0.06	-0.11	1.13	1.44	1.19	1.65	4.60	7.85
Hong Kong	Asia Pacific	High income	125	2.46	2.46	2.46	16.95	10.48	23.91	6.85	0.88
Hungary	Eastern Europe	High income	121	2.00	-0.11	2.46	2.12	1.48	3.87	2.34	6.01
India	Asia Pacific	Lower middle	471	-1.16	-1.16	-1.16	0.59	0.42	0.85	7.05	5.61

Country	Region	Income-Group	NO. of Observ.	*De Jure* FINLIB (2000 - 2009)	Min	Max	*De Facto* FINLIB (2000 - 2007)	Min	Max	GDP growth	Inflation
		income									
Indonesia	Asia Pacific	Lower middle income	335	1.13	1.13	1.13	0.98	0.86	1.31	5.13	8.44
Ireland	Western Europe	High income	37	2.46	2.46	2.46	21.75	13.15	25.73	2.42	2.96
Israel	Middle East and Africa	High income	97	2.01	1.40	2.46	1.96	1.55	2.43	3.62	1.99
Italy	Western Europe	High income	357	2.41	-1.16	2.46	2.55	1.96	2.82	-0.15	2.07
Japan	Asia Pacific	High income	59	2.46	2.46	2.46	1.40	1.02	1.94	0.73	-0.16
Jordan	Middle East and Africa	Upper middle income	89	2.43	2.19	2.46	2.46	2.11	3.01	6.70	4.15
Kazakhstan	Asia Pacific	Upper middle income	114	-1.16	-1.16	-1.16	1.46	1.09	1.90	8.50	9.27
Kenya	Middle East and Africa	Low income	113	1.13	1.13	1.13	0.81	0.72	0.93	4.08	8.95
Kuwait	Middle East and Africa	High income	43	1.13	1.13	1.13	2.76	2.40	3.09	4.96	3.47
Latvia	Eastern Europe	Upper middle income	97	2.41	2.19	2.46	1.93	1.27	2.49	4.53	6.64
Lithuania	Eastern Europe	Upper middle income	72	2.37	1.93	2.46	1.14	0.82	1.59	5.58	3.35
Madagascar	Middle East and Africa	Low income	19	-0.11	-0.11	-0.11	1.23	0.78	1.46	2.82	10.29
Malawi	Middle East and Africa	Low income	25	-1.31	-1.86	-1.16	1.38	0.45	2.16	3.18	15.29
Malaysia	Asia Pacific	Upper middle income	203	0.02	-0.11	1.13	1.95	1.78	2.22	4.70	2.17
Mali	Middle East and Africa	Low income	31	-1.16	-1.16	-1.16	1.14	0.79	1.51	5.34	2.96
Malta	Western Europe	High income	20	0.64	-1.16	2.46	7.87	4.87	12.75	1.82	2.51
Mauritius	Middle East and Africa	Upper middle income	44	2.39	1.22	2.46	0.84	0.73	1.02	4.28	6.69
Mexico	Latin America	Upper middle income	1	1.13	1.13	1.13	0.67	0.67	0.67	6.00	9.50

Country	Region	Income-Group	NO. of Observ.	*De Jure* FINLIB (2000 - 2009)	Min	Max	*De Facto* FINLIB (2000 - 2007)	Min	Max	GDP growth	Inflation
Moldova	Eastern Europe	Lower middle income	56	-1.16	-1.16	-1.16	1.51	1.36	2.14	4.33	10.68
Morocco	Middle East and Africa	Lower middle income	29	-1.16	-1.16	-1.16	1.14	0.99	1.34	4.71	1.94
Mozambique	Middle East and Africa	Low income	25	-1.16	-1.16	-1.16	1.79	1.34	2.22	7.69	10.62
Nepal	Asia Pacific	Low income	68	-1.16	-1.16	-1.16	0.72	0.62	0.81	4.10	6.66
Netherlands	Western Europe	High income	125	2.46	2.46	2.46	7.90	6.01	9.73	1.55	1.92
Niger	Middle East and Africa	Low income	17	-1.16	-1.16	-1.16	0.89	0.63	1.28	4.12	1.37
Nigeria	Middle East and Africa	Lower middle income	133	-0.57	-0.80	-0.53	1.32	0.93	1.75	9.53	12.73
Pakistan	Asia Pacific	Lower middle income	126	-1.16	-1.16	-1.16	0.66	0.61	0.75	5.19	9.17
Panama	Latin America	Upper middle income	150	2.46	2.46	2.46	3.23	3.00	3.72	6.33	2.49
Paraguay	Latin America	Lower middle income	103	1.33	0.87	1.40	1.08	0.81	1.40	2.45	8.28
Peru	Latin America	Upper middle income	82	2.46	2.46	2.46	1.12	1.05	1.24	5.05	2.60
Philippines	Asia Pacific	Lower middle income	114	0.08	0.08	0.08	1.32	1.29	1.46	4.66	5.79
Poland	Eastern Europe	High income	131	-0.02	-1.16	0.08	1.10	0.82	1.29	4.55	3.16
Portugal	Western Europe	High income	59	2.46	2.46	2.46	4.25	2.95	4.85	0.51	2.08
Romania	Eastern Europe	Upper middle income	157	1.42	-1.16	2.46	0.92	0.75	1.13	4.93	13.44
Saudi Arabia	Middle East and Africa	High income	90	1.13	1.13	1.13	1.29	1.03	1.92	3.36	2.10
Senegal	Middle East and Africa	Lower middle income	57	-1.16	-1.16	-1.16	1.22	0.92	1.44	4.07	1.94
Singapore	Asia Pacific	High income	41	2.46	2.46	2.46	10.03	8.75	10.44	5.31	2.01
Slovenia	Eastern Europe	High income	112	1.77	1.13	2.46	1.57	0.95	2.40	2.96	4.58
South Africa	Middle East	Upper middle	48	-1.16	-1.16	-1.16	1.53	1.29	1.75	3.87	6.06

Country	Region	Income-Group	NO. of Observ.	*De Jure* FINLIB (2000 - 2009)	Min	Max	*De Facto* FINLIB (2000 - 2007)	Min	Max	GDP growth	Inflation
	and Africa	income									
Spain	Western Europe	High income	150	2.46	2.46	2.46	3.01	2.26	3.60	2.35	2.92
Sri Lanka	Asia Pacific	Lower middle income	74	0.08	0.08	0.08	0.85	0.79	0.93	5.30	11.09
Sweden	Western Europe	High income	119	2.46	2.46	2.46	4.17	3.47	5.12	1.74	1.48
Switzerland	Western Europe	High income	720	2.46	2.46	2.46	10.39	9.03	13.57	1.81	0.96
Thailand	Asia Pacific	Upper middle income	143	-0.31	-1.16	-0.11	1.32	1.22	1.42	4.10	2.43
Tunisia	Middle East and Africa	Upper middle income	74	-1.16	-1.16	-1.16	1.62	1.41	1.70	4.86	3.52
Turkey	Western Europe	Upper middle income	119	-0.74	-1.16	0.08	0.89	0.76	1.01	3.68	12.51
United Kingdom	Western Europe	High income	397	2.46	2.46	2.46	7.66	6.01	9.33	1.57	2.07
United States	North America	High income	35	2.46	2.46	2.46	2.00	1.40	2.79	1.67	2.57
Venezuela, RB	Latin America	Upper middle income	34	-1.44	-1.59	-1.33	N/A	N/A	N/A	1.80	30.25
Venezuela, Rep. Bol.	Latin America	Upper middle income	175	0.21	-1.06	2.46	1.40	1.15	1.91	4.91	19.23
Vietnam	Asia Pacific	Lower middle income	93	-0.80	-1.16	-0.11	1.12	1.00	1.30	7.29	9.74
Zambia	Middle East and Africa	Lower middle income	60	2.46	2.46	2.46	2.14	0.88	3.21	5.34	16.46

CHAPTER 6

THE IMPACT OF FINANCIAL LIBERALISATION ON TECHNICAL EFFICIENCY AND PRODUCTIVITY GROWTH

6.1 Introduction

The empirical results of the previous chapter show that financial liberalisation has a significant impact on banks' cost and profit efficiency, using the one-step parametric SFA approach. This chapter complements the analysis of the previous chapter to investigate the impact of financial liberalisation on bank's technical efficiency as well as productivity growth. Following the approach of previous studies, a standard two-stage approach is used, which combines the non-parametric DEA (technical efficiency and Malmquist index) with panel data regressions.

There is a body of empirical literature that employs the non-parametric DEA approach, though mainly at individual country level, which indicate that financial deregulation has an impact on estimate banks' technical efficiency or total productivity growth (Berg et al., 1992; Wheelock and Wilson, 1999; Kumbhakar et al., 2001; Isik and Hassan, 2003; Tirtiroglu et al., 2005). With regard to cross country data, there has been no study linking financial liberalisation on bank productivity growth, although Hermes and Nhung (2010) investigate the impact of financial liberalisation on bank's technical efficiency for the Latin American countries.

Recently, there have been a limited number of cross country bank level studies which investigate the impact of external factors such as regulations, off balance activities, and foreign direct investment on bank productivity (Tanna, 2009; Delis et al., 2011; Lozano-Vivas and Pasiouras, 2013). The analysis of this chapter complements this line of literature by assessing the impact of financial liberalisation on banks' technical efficiency and total factor productivity growth (TFP) at cross-country level.

The empirical analysis of this chapter is divided into two parts. The first part of computes bank technical efficiency using the DEA approach. The second part concentrates on estimating total factor productivity (TFP) growth using the DEA-type Malmquist index. In each case, the non-parametric analysis is complemented with panel data regression to assess the impact of financial liberalisation on bank technical efficiency and productivity growth respectively.

6.1.1 Empirical methodology

6.1.2 Data envelopment analysis for technical efficiency

DEA is a non-parametric method used as linear programming to construct production frontier and to measure the efficiency relative to constructed frontier (Charnes et al., 1978). DEA constructs nonparametric piecewise production frontier for a group of decision making units (DMUs), through linear combination based on the actual input-output. It assumes that all firms produce with the same technology and there are no random errors, hence all the deviation from the estimation frontier refers to inefficiency. The efficiency score ranges from 0 to 1, an efficient DMU score equals to 1 relative to other sample DMUs.

Following most of the previous studies, this chapter drives the technical efficiency scores through the input-oriented models. Input-oriented model focus on minimising the total input costs for the given level of output. Generally, there are two basic models in DEA: the CCR-model (Charnes et al., 1978) and the BCC-model (Banker et al., 1984). The essential difference between these two models is that the former assumes constant return to scale whereas the latter assumes variable return to scale.

Assuming there are N DUMs (i.e. banks and firms etc.), K inputs to produce M outputs, X is K × N input matrix and Y is M × N output matrix. The input-oriented measurement of technical efficiency of an individual bank under CCR-model (constant return to scale) is presented by:

$$\min_{\lambda,\theta} \theta$$

$$s.t. \quad \sum_{j=1}^{n} X_j \lambda_j \leq \theta X_k$$

$$\sum_{j=1}^{n} Y_j \lambda_j \geq Y_k$$

$$\lambda_j \geq 0, j = 1, ..., n$$

The optimal θ can be obtained from the above linear programming which is efficiency score (technical efficiency score) for an individual bank. The value of θ is $\theta = 1$ or $\theta < 1$: $\theta = 1$ refers to bank is efficient which lies on the production frontier; $\theta < 1$ refers to a particular bank is relative inefficiency than the relative efficient bank.

Banker et al. (1984) further develop the DEA-model under variable returns to scale (the BCC-model). Since the CCR-model, as noted above, assumes all banks operating at optimal scale, however, the banks might experience economies or diseconomies of scale due to the imperfect market competition. Banker et al. (1984) suggest to decompose overall technical efficiency into pure technical efficiency (PTE) and scale efficiency (SE) under the assumption of variable returns to scale. The former relates to skills of managers utilising the inputs resources, the latter relates to the proportional reduction of inputs utilised to reach if the bank operates the optimal scale that the point of constant return to scale (Hermes and Nhung, 2010). The variable returns to scale assumes to the change the inputs do not proportional change in outputs. Thus, the input-oriented BCC-model can be calculated by adding a convexity constraint $\sum_{j=1}^{n} \lambda_j = 1$ to above equations.

The second stage investigates the relationship between efficiency and financial liberalisation, the estimation of panel-data regression can be expressed:

$$Y_{itc} = \alpha_0 + \alpha_1 FINLIB_{tc} + \alpha_2 Z_{itc} + u$$

where Y is a vector of efficiency scores for bank i in country c at time t; *FINLIB* is the proxy for financial liberalisation in country c at time t; Z is a set of other control variables which include bank-specific variables and country-specific variables; and u is the random error term.

6.1.3 Malmquist TFP change index[19]

The total factor productivity change is expressed as discussion in chapter 4, section 4.6:

$$TFPCH = PTECH \times SECH \times TECH$$

In the second stage analysis, the *TFPCH* is used as dependent variable in estimation of the following second-stage regression:

$$TFPCH_{itc} = \alpha_0 + \alpha_1 FINLIB_{tc} + \alpha_2 Z_{itc} + u$$

where *TFPCH* is total factor productivity growth of bank *i* in country *c* at time *t; FINLIB* is the proxy for financial liberalisation in country *c* at time *t*; *Z* is a set of other control variables which include bank-specific variables and country-specific variables; and *u* is the random error term.

6.2 Data and variables

6.2.1 Input and output

Following most of the previous studies, there are three output[20] variables: loans (Q_1), other earning assets (Q_2), non-interest income (Q_3). The third output variable is used as a proxy of off-balance activities, following Pasiouras (2008) and Lozano-Vivas and Pasiouras (2010). Three input variables are: fixed assets (W_1), deposits and short-term funding (W_2), and personnel expense (W_3).

6.2.2 Proxy for financial liberalisation

The measurement of financial liberalisation used in this chapter is the same with Chapter 5, more detailed discussion see Chapter 3 (different measurements of financial liberalisation). So that the Chinn-Ito index is used as a proxy of *de jure* financial liberalisation measure (Chinn and Ito, 2008) and has been employed in many of the studies (Umutlu et al., 2010; Bekaert et al., 2011; Gehringer, 2012). The chapter also uses the *de facto* measure (Kose et al., 2009) and measures of financial liberalisation provided by Abiad et al. (2008) as robustness analysis.

[19] More detail methodology discussion about Malmquist index, see chapter 4, section 4.6.
[20] The selections of output variables are the same with chapter 5.

6.2.3 Control variables

Bank-specific variables

There are four variables are used to control for difference in bank specific characteristics: ROE is the ratio of profit before tax over equity; EA is the ratio of equity over assets; LD is the total loan to deposits ratio, and SIZE is the logarithm of total assets that control for the size of bank. These bank-specific variables have been used in many of the previous studies and have impact on the bank efficiency (Isik and Hassan, 2003; Fries and Taci, 2005; Pasiouras, 2008; Pasiouras et al., 2009; Hermes and Nhung, 2010).

ROE, return to equity, is expected positively related to the bank efficiency, since higher ratio of ROE as a proxy for the competitiveness of a bank and is related to the higher profitability. EA is used as a proxy for capital strength. Lower ratio of equity to assets relates to higher risk and leverage that lower the efficiency (Lozano-Vivas et al., 2001). LD reflects ability of banks to transform deposits to loans (Dietsch and Lozano-Vivas, 2000) and expects the higher ratio lowers costs and improves efficiency of banks (Fries and Taci, 2005). The control variable of SIZE, the logarithm of total assets, which reflects size of banks, the larger bank might benefit of economies of scale. In this case, the larger value of SIZE, the higher efficiency might be.

Regulatory and supervisory variables

Four variables are used to control for differences in banking regulations across countries and these are based on the 2001, 2003 and 2008 versions of the database originally provided by Barth et al. (2001): capital requirements index (), index of official supervisory power (SUP), index of private monitoring (PRIM), and index of level bank activities restrictiveness (ACT).

Market structure and financial development variables

CONC measures bank concentration that is defined as a ratio of the total assets of three largest commercial banks to the total assets of all commercial banks of a country. *CLAIM* is the ratio of claims on the private sector to GDP that captures the depth of financial intermediation.

Macroeconomic variables

GDPGR is the real GDP growth rate. INFA is the annual inflation rate. These two variables are used to control the macroeconomic environment as in Grigorian and Manole (2002) and Pasiouras et al. (2009).

6.3 Empirical results

6.3.1 Impact of financial liberalisation on technical efficiency of banks

6.3.2 Basic results

Table 6-1 presents the input-oriented efficiency scores of banks based on the common (global) frontier. The mean overall technical efficiency, pure technical efficiency and scale efficiency are 0.3529, 0.4850 and 0.7849, respectively. The results imply that, on average, banks could improve their overall technical efficiency by 64.51%, and improve their pure technical efficiency by 51.5%. In addition, the mean scale efficiency scores reflect that the sample banks deviate by 21.51% from their efficient size. In Table 6-1, Panel A depicts the mean efficiency by year, Panel B by region and Panel C by income group. With regard to bank efficiency by year, on average, the overall technical efficiency presents a significant and sharp decline from 0.5082 in 2000 to 0.2415 in 2005, and fluctuates slightly from 2005 to 2009. Meanwhile, the pure technical efficiency declines from 0.6045 in 2000, to 0.3802 in 2009. The scale efficiency fluctuates around 0.80 during the estimation period. Regarding the comparison among different regions as seen in Panel B, the most efficient region is North America, where the OTE and the PTE are 0.4380 and 0.6594, respectively. The region of Australasia is slightly less efficient than is North America, as the OTE and the PTE are 0.4307 and 0.6453, respectively. In addition, sample banks in the Asia-Pacific region are, on average, the most scale efficient at around 0.8133. In terms of the comparison of different levels of income groups in Panel C, it can be seen that the high income group is the most efficient, as the OTE, the PTE and the SE are 0.4023, 0.5302 and 0.8052, respectively. By contrast, the least efficient income group is the lower-middle income group: the OTE and the PTE are 0.2941 and 0.4166, respectively. The least scale efficient is the lower income group, at 0.6540.

Table 6-2 represents the percentage of banks (by region) that experience increasing return to scale (IRS), constant return to scale (CRS) and decreasing return to scale (DRS). In Panel A, for example, in the Asia-Pacific region, of 2119 observations, 8.16% of observations are scale efficient on average (CRS), while the majority, or 91.84% of observations, are scale inefficient (IRS or DRS). Of the scale inefficient banks, 60.97% are experiencing IRS and 30.86% of the banks are experiencing DRS. Similarly, Panel B shows the percentage of banks (by income group) that are experiencing IRS, CRS and DRS.

Table 6-1 Technical, Pure technical and Scale efficiency (DEA)

	Number of observations	OTE	PTE	SE
Panel A: mean by year				
2000	756	0.5082	0.6405	0.8308
2001	816	0.4382	0.6033	0.7580
2002	865	0.4611	0.5898	0.8228
2003	954	0.4091	0.5603	0.7656
2004	1121	0.3695	0.5134	0.7773
2005	1284	0.2415	0.4010	0.7216
2006	1339	0.3097	0.4421	0.7801
2007	1318	0.3766	0.4755	0.8380
2008	1248	0.2857	0.4017	0.7836
2009	1206	0.2709	0.3802	0.7854
Panel B: mean by geographical region				
Asia Pacific	2118	0.3324	0.4481	0.8133
Australasia	68	0.4307	0.6453	0.7259
Eastern Europe	1283	0.2982	0.4215	0.7675
Latin America	1950	0.3079	0.4601	0.7414
Middle East and Africa	1266	0.2989	0.4308	0.7632
North America	128	0.4380	0.6594	0.6975
Western Europe	4094	0.4149	0.5445	0.8067
Panel C: mean by country group				
High income	5375	0.4023	0.5302	0.8052
Upper middle income	2922	0.3135	0.4441	0.7755
Lower middle income	2106	0.2941	0.4166	0.7774
Low income	504	0.3011	0.5258	0.6540
Overall mean	10907	0.3529	0.4850	0.7849

Note: The mean value by year, geographical region and income country group. OTE refers overall technical efficiency, PTE refers to pure technical efficiency, and SE refers to scale efficiency.

Table 6-2 Percentage of banks of RTS by region and income group

	Observations	IRS	CRS	DRS	Total
Asia Pacific	2119	60.97%	8.16%	30.86%	100.00%
Australasia	68	26.47%	10.29%	63.24%	100.00%
Eastern Europe	1284	70.87%	5.45%	23.68%	100.00%
Latin America	1947	65.18%	8.12%	26.71%	100.00%
Middle East and Africa	1267	67.64%	6.39%	25.97%	100.00%
North America	128	74.22%	7.03%	18.75%	100.00%
Western Europe	4094	56.74%	10.19%	33.07%	100.00%
	Observations	**IRS**	**CRS**	**DRS**	**Total**
High income	5375	55.98%	9.43%	34.59%	100.00%
Low income	505	91.09%	2.18%	6.73%	100.00%
Lower middle income	2108	73.67%	7.64%	18.69%	100.00%
Upper middle income	2919	59.68%	8.08%	32.24%	100.00%

Note: IRS refers to increasing returns to scale; CRS refers to constant returns to scale; DRS refers to decreasing returns to scale.

6.3.2.1 Financial liberalisation and bank technical efficiency

This section concentrates on the empirical results regarding the impact of financial liberalisation on the efficiency of banks by regressing their efficiency scores for overall technical efficiency, pure technical efficiency and scale efficiency as dependent variables on measures of financial liberalisation, together with the control variables relating to regulation, macroeconomics, market structure and bank specific variables. The results[21], shown in Table 6.3, are based on the use of the fixed effects model[22] following McDonald (2009) who suggests the use of panel least squares is preferred to the Tobit model.

De jure financial liberalisation and technical efficiency

Columns [1] to [5] of Table 6-3 present the impact of *de jure* financial liberalisation (Chinn and Ito, 2008) on the overall technical efficiency of banks from 2000 to 2009. The empirical evidence shows that financial liberalisation is negatively

[21] White's heteroskedasticity-robust standard errors are reported in the results (for adjusting the heteroskedasticity of the cross-section after employing "the modified Wald statistic test" for group-wise heteroskedasticity in the residuals of a fixed effect regression model under the null hypothesis of homoscedasticity, following (Greene, 2000), using the Stata package along the command line "xttest3", with the command "robust" for the heteroskedasticity-robust standard errors computation.

[22] Also, the results of the Hausman test confirms that the fixed-effects model is preferred over the random effects model .

related to the overall technical efficiency and is statistically significant at the 1% level. In column [1], we control for the bank-specific characteristics, column [2] shows the added regulatory and supervisory variables, column [3] includes two added market structure variables, column [4] includes the added macro-economic development variables, while column [5] includes all the control variables. The results reveal that the impact of financial liberalisation on banks' overall technical efficiency is uniformly negative in all cases. The results imply that financial liberalisation increases the input waste. The increased input waste might be a result of the adaption to the new environment that is caused by financial liberalisation (Isik and Hassan, 2003). In addition, it can be argued that financial liberalisation might induce excessive risk-taking (Ranciere et al., 2006), which increases the costs of managing the excessive risk-taking and lowers the efficiency of the banks. Similar results are found in columns [1] to [5] of Table 6-4, where the results reveal that financial liberalisation has a negative impact on the pure technical efficiency. With regard to the scale efficiency (SE), the regression results in Table 6-5 suggest that financial liberalisation is not statistically significant, but does relate negatively to the scale efficiency. Overall, the results imply that, on average, financial liberalisation does not improve the efficiency of banks and does increase their input waste, leading to a loss of pure technical efficiency.

Concerning the control variables, the ACT (restrictions on bank activities) is statistically significant and is negatively related to the overall and pure technical efficiency in all cases. One potential explanation for this finding is that fewer restrictions on bank activities allow banks to participate in diversified activities and to consolidate the scale and scope economies (Pasiouras et al., 2009). A market structure variable CONC is negatively and statistically significantly related to the overall technical efficiency in all cases, and is negatively related to the pure technical efficiency in most cases. This result implies that the more competition banks encounter, the more efficient they are (Delis and Tsionas, 2009). The ROE has a positive influence on the overall technical efficiency and on the pure technical efficiency in all cases; this result is consistent with that of Hermes and Nhung (2010). A bank-specific variable, SIZE, is statistically significant and negatively related to the overall and the pure technical efficiency, but positively related to scale efficiency. These results suggest that large

banks are less technically efficient than are small banks, which is consistent with the findings of Christopoulos et al. (2002). However, Benston (1972) indicates that large banks are preferred ceteris paribus, which would lower the costs and benefit the scale efficiency. In addition, the variable GDP growth (GDPG) is positively and statistically significantly related to the scale efficiency.

De facto financial liberalisation and bank technical efficiency

Columns [5] to [10] of Table 6-3 show the empirical results for the *de facto* financial liberalisation measure (Kose et al. 2009) on the banks' overall technical efficiency, pure technical efficiency and scale efficiency, respectively, from the period between 2000 and 2007[23]. The results reveal that financial liberalisation is negatively and statistically significantly related to the overall technical efficiency. The results are consistent with the results showing the negative impact of the *de jure* financial liberalisation on efficiency. However, with regard to pure technical efficiency, Table 6-4 shows that the relationship between *de facto* financial liberalisation and pure technical efficiency is negative, but is not statistically significant in most of the cases. Regarding the results of scale efficiency in Table 6-5, the *de facto* financial liberalisation is negatively and statistically significantly related to the scale efficiency in all cases.

[23] Since the *de facto* financial liberalisation index of Kose et al. (2009) is only updated to 2007, these regressions on efficiency are based on the sample from 2000 to 2007.

Table 6-3 Financial Liberalisation and Overall Technical Efficiency

	De jure financial liberalisation index (2000-2009)					*De facto* financial liberalisation index (2000-2007)				
	Bank Specific	**Regulation and Supervision**	**Market Structure**	**Macro-economic Condition**	**All controls**	**Bank Specific**	**Regulation and Supervision**	**Market Structure**	**Macro-economic Condition**	**All controls**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
FINLIB	-0.00929***	-0.0180***	-0.00798**	-0.0117***	-0.0143***	-0.0135***	-0.0114***	-0.0146***	-0.0131***	-0.0105***
	(-3.17)	(-6.67)	(-2.51)	(-3.90)	(-4.59)	(-4.91)	(-4.54)	(-5.23)	(-4.81)	(-4.23)
ROE	0.0546***	0.0553***	0.0532***	0.0551***	0.0495***	0.0413***	0.0399***	0.0406***	0.0448***	0.0412***
	(3.50)	(3.51)	(3.44)	(3.41)	(3.26)	(2.84)	(2.78)	(2.81)	(3.05)	(2.91)
EA	-0.129	-0.0637	-0.123	-0.114	-0.0354	-0.0420	0.0243	-0.0434	-0.0340	0.0260
	(-1.59)	(-0.82)	(-1.52)	(-1.41)	(-0.46)	(-0.50)	(0.30)	(-0.51)	(-0.40)	(0.32)
LD	0.00105	0.00101	0.00105	0.00102	0.00100	0.000472	0.000411	0.000472	0.000477	0.000423
	(1.14)	(1.08)	(1.15)	(1.14)	(1.08)	(1.10)	(0.97)	(1.07)	(1.10)	(0.92)
SIZE	-0.0667***	-0.0479***	-0.0641***	-0.0665***	-0.0396***	-0.0502***	-0.0324***	-0.0512***	-0.0448***	-0.0243***
	(-15.35)	(-11.21)	(-13.49)	(-15.21)	(-8.36)	(-9.58)	(-6.13)	(-9.19)	(-8.48)	(-4.22)
		-0.00373**			-0.00442**		-0.00358**			-0.00494***
		(-2.12)			(-2.48)		(-2.07)			(-2.80)
SUP		-0.000512			-0.000418		0.00186			0.00177
		(-0.39)			(-0.32)		(1.48)			(1.43)
PRI		-0.000315			0.000551		-0.00529*			-0.00480*
		(-0.10)			(0.18)		(-1.89)			(-1.72)
ACT		-0.0854***			-0.0903***		-0.0718***			-0.0677***
		(-12.83)			(-13.03)		(-11.93)			(-10.90)
CONC			-0.0343*		-0.0424**			0.0908***		0.0771***
			(-1.89)		(-2.40)			(2.81)		(2.65)
CLAIMS			-0.0116		-0.0531***			0.0110		-0.0528***
			(-0.83)		(-3.59)			(0.63)		(-2.92)
GDPG				0.0000161	0.0000681				-0.00512***	-0.00427***
				(0.04)	(0.17)				(-8.11)	(-6.69)
INFLA				-0.0015***	-0.000905**				-0.00120***	-0.000382
				(-4.10)	(-2.25)				(-2.67)	(-0.82)
_cons	0.864***	0.958***	0.873***	0.871***	0.969***	0.778***	0.835***	0.726***	0.764***	0.780***
	(24.09)	(26.55)	(23.79)	(23.98)	(25.98)	(19.12)	(20.59)	(16.30)	(18.77)	(17.82)
N	10907	10907	10907	10907	10907	8453	8453	8453	8453	8453
R^2	0.084	0.124	0.085	0.086	0.130	0.054	0.091	0.056	0.065	0.099

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

Table 6-4 Financial Liberalisation and Pure Technical Efficiency

	De jure financial liberalisation index (2000-2009)					*De facto* financial liberalisation index (2000-2007)				
	Bank Specific	**Regulation and Supervision**	**Market Structure**	**Macro-economic Condition**	**All controls**	**Bank Specific**	**Regulation and Supervision**	**Market Structure**	**Macro-economic Condition**	**All controls**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
FINLIB	-0.00985***	-0.0163***	-0.0122***	-0.0120***	-0.0162***	-0.00407	-0.00222	-0.00639**	-0.00399	-0.00369
	(-2.70)	(-4.35)	(-2.93)	(-3.36)	(-3.91)	(-1.41)	(-0.78)	(-2.21)	(-1.40)	(-1.32)
ROE	0.0522***	0.0526***	0.0545***	0.0578***	0.0550***	0.0491***	0.0483***	0.0484***	0.0532***	0.0503***
	(3.11)	(3.09)	(3.18)	(3.21)	(3.09)	(2.98)	(2.92)	(2.96)	(3.19)	(3.06)
EA	-0.228***	-0.181**	-0.234***	-0.224***	-0.177**	-0.145*	-0.0935	-0.149*	-0.141*	-0.103
	(-2.96)	(-2.34)	(-3.00)	(-2.88)	(-2.26)	(-1.78)	(-1.14)	(-1.77)	(-1.70)	(-1.24)
LD	0.000669	0.000634	0.000665	0.000666	0.000636	0.000234	0.000193	0.000231	0.000252	0.000216
	(1.13)	(1.05)	(1.12)	(1.12)	(1.04)	(0.96)	(0.80)	(0.90)	(0.98)	(0.75)
SIZE	-0.133***	-0.119***	-0.136***	-0.134***	-0.119***	-0.126***	-0.112***	-0.129***	-0.119***	-0.107***
	(-23.41)	(-19.90)	(-21.90)	(-23.54)	(-17.92)	(-18.78)	(-15.99)	(-18.42)	(-17.39)	(-14.14)
		-0.00341			-0.00374*		-0.00213			-0.00352*
		(-1.56)			(-1.73)		(-1.00)			(-1.69)
SUP		-0.000695			-0.000753		0.000635			0.000400
		(-0.38)			(-0.41)		(0.37)			(0.24)
PRI		0.00151			0.00160		-0.00159			-0.00271
		(0.40)			(0.42)		(-0.44)			(-0.76)
ACT		-0.0621***			-0.0609***		-0.0584***			-0.0467***
		(-7.14)			(-6.91)		(-6.95)			(-5.62)
CONC			0.0155		0.00680			0.126***		0.124***
			(0.69)		(0.30)			(3.42)		(3.59)
CLAIMS			0.0218		-0.0137			0.0414**		-0.0104
			(1.34)		(-0.78)			(2.01)		(-0.49)
GDPG				-0.00136**	-0.000915				-0.0063***	-0.0056***
				(-2.46)	(-1.60)				(-6.53)	(-6.01)
INFLA				-0.00117**	-0.000748				-0.000787	-0.0000208
				(-2.22)	(-1.38)				(-1.28)	(-0.03)
_cons	1.497***	1.563***	1.495***	1.514***	1.572***	1.441***	1.484***	1.367***	1.418***	1.392***
	(33.20)	(32.63)	(32.81)	(33.47)	(32.76)	(28.99)	(28.60)	(26.26)	(28.44)	(26.04)
N	10907	10907	10907	10907	10907	8453	8453	8453	8453	8453
R^2	0.197	0.211	0.198	0.199	0.212	0.154	0.169	0.159	0.165	0.178

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

Table 6-5 Financial Liberalisation and Scale Efficiency

	De jure financial liberalisation index (2000-2009)					*De facto* financial liberalisation index (2000-2007)				
	Bank Specific	**Regulation and Supervision**	**Market Structure**	**Macro-economic Condition**	**All controls**	**Bank Specific**	**Regulation and Supervision**	**Market Structure**	**Macro-economic Condition**	**All controls**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
FINLIB	-0.00430	-0.00861***	0.000819	-0.00482	-0.00304	-0.0110***	-0.0100***	-0.00953***	-0.0107***	-0.00672***
	(-1.37)	(-2.70)	(0.24)	(-1.51)	(-0.88)	(-4.78)	(-4.57)	(-4.18)	(-4.64)	(-3.17)
ROE	0.0115	0.0119	0.00614	0.00352	-0.00107	-0.00418	-0.00539	-0.00461	-0.00428	-0.00628
	(0.78)	(0.81)	(0.43)	(0.24)	(-0.08)	(-0.28)	(-0.37)	(-0.31)	(-0.29)	(-0.43)
EA	0.0626	0.0946	0.0790	0.0784	0.131**	0.107	0.135**	0.110*	0.112*	0.149**
	(0.96)	(1.47)	(1.20)	(1.20)	(2.03)	(1.63)	(2.07)	(1.65)	(1.70)	(2.28)
LD	0.000482	0.000460	0.000487	0.000447	0.000441	0.000321	0.000277	0.000328	0.000309	0.000270
	(1.05)	(0.99)	(1.07)	(1.03)	(0.98)	(1.11)	(0.97)	(1.10)	(1.11)	(0.93)
SIZE	0.0576***	0.0669***	0.0648***	0.0591***	0.0785***	0.0719***	0.0796***	0.0753***	0.0709***	0.0855***
	(13.60)	(14.73)	(14.27)	(14.01)	(16.03)	(15.02)	(15.70)	(15.19)	(14.12)	(15.42)
		-0.00188			-0.00229		-0.00323**			-0.00353**
		(-1.17)			(-1.43)		(-2.02)			(-2.23)
SUP		0.000534			0.000800		0.00218*			0.00241*
		(0.42)			(0.62)		(1.72)			(1.93)
PRI		0.00178			0.00293		-0.00259			-0.000348
		(0.68)			(1.13)		(-1.05)			(-0.14)
ACT		-0.0440***			-0.0535***		-0.0279***			-0.0370***
		(-5.92)			(-7.27)		(-3.89)			(-5.36)
CONC			-0.0573***		-0.0574***			-0.00219		-0.0187
			(-3.19)		(-3.18)			(-0.07)		(-0.65)
CLAIMS			-0.0477***		-0.0610***			-0.0475***		-0.0766***
			(-3.94)		(-4.91)			(-3.15)		(-5.20)
GDPG				0.00211***	0.00164***				0.000312	0.000487
				(4.56)	(3.40)				(0.37)	(0.59)
INFLA				-0.000590	-0.000213				-0.000579	-0.000419
				(-1.36)	(-0.49)				(-1.09)	(-0.77)
_cons	0.356***	0.387***	0.367***	0.340***	0.384***	0.290***	0.303***	0.296***	0.298***	0.322***
	(10.72)	(11.18)	(11.07)	(10.22)	(11.11)	(8.15)	(8.05)	(7.75)	(8.13)	(7.85)
N	10907	10907	10907	10907	10907	8453	8453	8453	8453	8453
R^2	0.058	0.069	0.063	0.062	0.080	0.068	0.076	0.070	0.068	0.081

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

Financial liberalisation (Abiad et al., 2008) and bank technical efficiency

Table 6-6, Table 6-7 and Table 6-8 present the regression results when employing the six dimensions of financial liberalisation measures that were developed by Abiad et al. (2008) for the period between 2000 and 2005, controlling for the bank-specific and country-specific characteristics. The results suggest that CREDIT, credit allocation liberalisation, is statistically significant and positively related to overall technical efficiency and scale efficiency in all cases. Hermes and Lensink (2008) indicate that the liberalisation of government credit control decreases market power enhances the market conditions and the competition. Thus, relaxing credit control improves the efficiency of capital allocation, reducing the overhead costs and hence improving the banks' efficiency. Two other variables, namely entry barrier liberalisation (ENTRY) and privatisation (PRIVATI), are negatively and statistically significantly related to the overall technical efficiency and pure technical efficiency in all cases. A possible explanation for this negative relationship can be seen in the findings of Casu and Girardone (2009), who indicate that competition accelerates consolidation in the banking industry, which might increase concentration. The "quiet life hypothesis", first introduced by Hicks (1935), states that managers benefit from monopoly power when there is no significant competition. Managers who enjoy the "quiet life" do not need to control their costs, which ultimately leads to the lower cost efficiency of their banks (Berger and Hannan, 1998). Hence, the entry barriers of liberalisation and privatisation might accelerate consolidation for the banking sector, and the increased monopoly power might lower the banks' efficiency. With regard to interest rate liberalisation (INTRA), which is negatively related to the overall and pure technical efficiency, it is only statistically significant at 10% in most of the cases. Regarding the impact of capital account liberalisation (CAPITAL) and equity market liberalisation (EQUITY) on technical and pure technical efficiency, the results are not statistically significant in all cases. In terms of the scale efficiency, the results in Table 6-8 show that credit control liberalisation (CREDIT) is positively and statistically significantly related to scale efficiency, while privatisation (PRIVATI) is negatively and statistically significantly related to scale efficiency.

With regard to the results for the other control variables, capital requirement () and restrictions on the banks' activities (ACT) are negatively and statistically significant

in all cases in terms of both technical and scale efficiency. The results imply that higher capital requirements and more restrictions on the banks' activities decrease the banks' efficiency. By contrast, SIZE is positively and statistically significantly related to scale efficiency in all cases. This implies that increasing the size of the banks would help them to decrease their input waste; this finding is consistent with that of Benston (1972), who indicates that large banks are preferred ceteris paribus because of the lower costs.

Table 6-6 Financial Liberalisation and Overall Technical Efficiency: Abiad et al. (2008)

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

Table 6-7 Financial Liberalisation and Pure Technical Efficiency: Abiad et al. (2008)

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

Table 6-8 Financial Liberalisation and Scale Efficiency: Abiad et al. (2008)

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

6.3.2.2 Specific frontier analysis

Similar to the robustness analysis conducted in Chapter 5 with cost and profit efficiency, this section analyses the impact of financial liberalisation on the banks' technical efficiency, based on regional frontiers (different income group regions). There are three reasons for employing regional frontier analysis. Firstly, computing the common (global) frontier efficiency in the previous section required the assumption that all banks produce via the same technology; hence, the global frontier analysis does not reflect the differences across regions or countries. Secondly, it has been argued that the impact of financial liberalisation on financial development or on macroeconomic development depends on the initial level of economic development, financial market development and the different qualities of the institutions in the various countries (Broner and Ventura, 2010). Hence, the impact of financial liberalisation on bank efficiency might vary in different countries according to the level of economic development. Thirdly, according to the regression model in the previous section, using the variable of GDP growth is not sufficient to capture the different economic development levels of different countries.

Table 6-9 presents the regression results of *de jure* financial liberalisation on the banks' overall technical efficiency, pure technical efficiency and scale efficiency, based on the sample from 2000 to 2009. The results show that the impact of financial liberalisation on the overall and pure technical efficiency still negatively influences the efficiency. This finding is consistent with the results in the previous section, which were based on the common frontier. However, the effects are statistically significant only in the high income group and in the upper-middle income group countries. With regard to scale efficiency, the results are not statistically significant in all cases, which is consistent with the results of the global frontier analysis in previous section.

Table 6-9 Financial Liberalisation and Bank Efficiency (Income Group)

	Overall Technical Efficiency				Pure Technical Efficiency				Scale Efficiency			
	High Income group	Upper and Middle Income group	Middle and Lower Income group	Lower Income group	High Income group	Upper and Middle Income group	Middle and Lower Income group	Lower Income group	High Income group	Upper and Middle Income group	Middle and Lower Income group	Lower Income group
FINLIB	-0.0174*	-0.0200***	-0.0121	-0.00306	-0.0156*	-0.0201***	-0.00704	-0.0247	-0.00700	-0.00140	-0.00833	0.0272
	(-2.56)	(-4.16)	(-0.72)	(-0.07)	(-2.02)	(-3.81)	(-0.38)	(-0.56)	(-1.00)	(-0.27)	(-0.54)	(0.90)
	0.0151***	0.00506	-0.0154***	-0.0345*	0.0101***	0.00913**	-0.00617	-0.0182*	0.00613**	-0.00298	-0.0109**	-0.0171
	(5.84)	(1.68)	(-3.61)	(-2.17)	(3.50)	(2.80)	(-1.52)	(-2.36)	(2.67)	(-1.01)	(-3.12)	(-1.29)
SUP	0.0127***	-0.000538	-0.00643	-0.0152	0.00905***	0.00221	-0.00327	-0.00377	0.00569**	-0.00189	-0.00361	-0.0134
	(6.05)	(-0.24)	(-1.89)	(-0.97)	(4.06)	(0.79)	(-0.68)	(-0.32)	(3.23)	(-0.87)	(-0.97)	(-1.25)
PRI	0.0170**	-0.0328***	0.00219	-0.0259	0.00531	-0.0231***	0.00790	-0.0114	0.0199***	-0.0148*	-0.00607	-0.0170
	(3.29)	(-5.53)	(0.41)	(-1.73)	(0.93)	(-3.54)	(1.12)	(-1.53)	(4.53)	(-2.58)	(-1.14)	(-1.32)
ACT	-0.138***	-0.0353**	-0.0287*	-0.0221	-0.0948***	-0.0232	0.0171	-0.00603	-0.0646***	-0.0190	-0.0503***	-0.0193
	(-8.40)	(-3.08)	(-2.17)	(-0.85)	(-5.77)	(-1.62)	(1.17)	(-0.33)	(-4.69)	(-1.72)	(-3.99)	(-0.78)
CONC	-0.0500	0.0459	0.00205	0.375***	-0.0543	0.0208	0.0714	0.160***	-0.0294	0.0348	-0.0647	0.245***
	(-1.49)	(1.69)	(0.07)	(6.00)	(-1.68)	(0.70)	(1.59)	(3.43)	(-0.94)	(1.58)	(-1.81)	(5.42)
CLAIMS	-0.0536**	0.129***	-0.158**	0.289***	-0.0316	0.132***	0.0588	0.178***	-0.0383**	0.0312	-0.217***	0.130*
	(-3.23)	(3.89)	(-3.15)	(3.83)	(-1.85)	(4.02)	(1.12)	(3.54)	(-3.12)	(1.07)	(-4.55)	(2.59)
GDPG	-0.00764***	-0.00162*	-0.00762***	-0.000395	-0.00588***	-0.00116	-0.00418**	-0.00109	-0.00303***	-0.000781	-0.00389***	0.000711
	(-7.44)	(-2.22)	(-5.44)	(-0.20)	(-5.60)	(-1.27)	(-2.68)	(-0.71)	(-3.72)	(-1.17)	(-3.67)	(0.60)
INFLA	-0.00302	-0.0000852	-0.00316**	0.000741	-0.00297	-0.000113	-0.00238*	0.000267	9.71e-08	0.000121	-0.00134	0.000557
	(-1.74)	(-0.16)	(-3.10)	(0.88)	(-1.80)	(-0.20)	(-2.37)	(0.41)	(0.00)	(0.26)	(-1.73)	(0.91)
ROE	0.0649*	0.0904***	0.0438*	0.0581	0.0366	0.0930***	0.0179	0.0592	0.0575***	0.0169	0.0312**	0.00565
	(2.11)	(3.93)	(2.27)	(1.42)	(1.19)	(3.73)	(0.95)	(1.63)	(3.34)	(0.89)	(2.85)	(0.25)
EA	0.0700	-0.0461	0.164	0.107	-0.0650	0.0959	0.188*	0.519*	0.0886	-0.165	-0.0272	-0.414
	(0.62)	(-0.36)	(1.18)	(0.33)	(-0.66)	(0.82)	(2.07)	(2.49)	(1.00)	(-1.79)	(-0.18)	(-1.48)
LD	0.000826	0.00327	0.0753*	0.0196*	0.000485	0.00206	0.0559	0.0143	0.000378	0.00139	0.0279	0.00646
	(1.05)	(0.92)	(2.11)	(2.29)	(0.96)	(0.69)	(1.73)	(1.61)	(1.00)	(1.32)	(1.00)	(1.58)
SIZE	-0.0651***	-0.0208**	-0.0258**	-0.0193	-0.0920***	-0.0348***	-0.0240**	-0.0312***	0.00972	0.00441	-0.00928	0.0105
	(-7.37)	(-2.93)	(-2.96)	(-1.78)	(-10.59)	(-3.66)	(-2.63)	(-3.96)	(1.59)	(0.56)	(-0.94)	(1.18)
_cons	1.059***	0.871***	1.092***	1.162***	1.429***	0.974***	0.853***	1.086***	0.733***	0.930***	1.294***	1.105***
	(15.12)	(12.11)	(15.11)	(5.10)	(18.38)	(10.98)	(11.80)	(6.49)	(14.21)	(14.14)	(16.78)	(6.73)
N	5374	2920	2108	505	5374	2920	2108	505	5374	2920	2108	505
R^2	0.179	0.078	0.141	0.215	0.168	0.079	0.061	0.162	0.032	0.020	0.098	0.145

Note: the classification of income group is according to The World Bank. The groups are: low income, $1,025 or less; lower middle income, $1,026 - $4,035; upper middle income, $4,036 - $12,475; and high income, $12,476 or more. Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

6.3.3 Impact of financial liberalisation on total factor productivity growth

6.3.3.1 Basic results

Moving on the analysis of TFP growth, Table 6-10 presents the average of the total factor productivity change (TFPCH) for each year from 2004 to 2009 based on a sample of 705 commercial banks covering 83 countries[24]. The TFPCH index has two components, namely technology progress change (TEFCH) and technical efficiency change (TECH). The TEFCH is further decomposed into pure technical efficiency changes (PECH) and scale efficiency changes (SECH). The total factor productivity change (TFPCH) is the relative index of the previous year; in this case, when the index is greater than one it reveals a positive TFP growth, while an index of less than one indicates that the TFP declined. In Table 6-10, the results suggest that, on average, the total productivity growth was 0.4% from 2004 to 2009, but the increase was mainly caused by the technology progress change of 2.4%. However, the technical efficiency change is -1.9%, which might be explained by the external shock of the recent and on-going global financial crisis. Moreover, the results imply that there is a trade-off between the efficiency gains and the technology progress (Tanna, 2009). For example, from 2004 to 2005, the technology progress change was -8.8%, while the technology efficiency change was 11.1%; hence, the net total productivity growth change was 1.4%. However, from 2005 to 2008, the trend was reversed. On average, banks experienced increased technology progress change in conjunction with decreased technical efficiency. The results for the pure technical efficiency change (PECH) and the scale efficiency change (SECH) are shown in Table 6-10. For example, from 2008-2009, there was an average efficiency change of 9.6%, since the pure technical efficiency change was 3.6% as a result of managerial improvement and a scale efficiency change of 5.8%.

[24] Calculation of the DEA-Malmquist index requires the strict balancing of panel sample data. As a result, the period from 2004 to 2009 is used in the calculation of the Malmquist index in order to maintain the largest amount of sample data. Hence the sample includes 705 commercial banks across 83 countries.

Table 6-10 Malmquist Index Decomposition

Year	TECHCH	EFFCH	PECH	SECH	TFPCH
2004-2005	0.912	1.111	1.078	1.031	1.014
2005-2006	1.056	0.953	0.963	0.99	1.006
2006-2007	1.011	0.982	1.028	0.956	0.993
2007-2008	1.261	0.797	0.851	0.936	1.005
2008-2009	0.915	1.096	1.036	1.058	1.003
Mean	1.024	0.981	0.988	0.993	1.004

6.3.3.2 Financial liberalisation and the total factor productivity

Table 6-11 reports the main results of the second-stage analysis relating to the impact of financial liberalisation on TFP growth. Here, in order to maintain the largest sample size covering 705 commercial banks from 83 countries over the period 2004-09, only the de jure measure of financial liberalisation (FINLIB) is used. The results suggest that financial liberalisation is positively related to the total factor productivity growth in all the specification models. However, most of the coefficients are statistically insignificant. The results imply that financial liberalisation does not significantly influence the total factor productivity growth of banks. A possible explanation might be that the total factor productivity change can be decomposed into technology change and technical efficiency change. There might be a trade-off between the impact of financial liberalisation on technical efficiency change and on technology change. The study by Zhao et al. (2008) indicate that the total factor productivity growth of the banking sector during the financial deregulation period was mainly derived from technological progress, which may affect technical efficiency but not necessarily productivity growth. Correspondingly, as our empirical results show, financial liberalisation has a negative impact on technical efficiency but do not provide sufficient evidence to suggest that financial liberalisation also contributes to total factor productivity growth. However, with all the added control variables (column 5 in Table 6-11), the impact of financial liberalisation (FINLIB) on bank total factor productivity growth (TFPCH) becomes statistical significant and positive.

Among the bank specific factors, profitability (ROE) and the ratio of loans to deposits (LD) are statistically significant and positively related to bank productively, and their influences are robustly significant across all specifications. In contrast, the effects of capital strength (EA) and bank size (SIZE) are positive but statistically insignificant.

Concerning the regulatory and supervisory variables, the impact of activities restrictions (ACT) is statistically significant and negatively related to bank productivity, and this finding holds across all of the specifications with the regulatory controls included (columns 2 and 5). The result implies that more restrictions on banks' activities decrease the productivity of banks, or conversely, less restrictions increase productivity. Barth et al. (2003) point out that fewer restrictions could provide greater profit opportunities, which would yield productivity improvements. However, the other three regulatory variables, capital requirement (CAPR), supervisor power (SUP) and private monitoring (PRI) are all statistically insignificant except in one case where all the control variables are included (column 5). In general, the results indicate that regulatory influences relating capital requirements (CAPR) and official supervision (SUP) do not influence bank productivity, although a greater degree of market discipline associated with private monitoring (PRI) has a positive impact on bank productivity.

Turning to the country-specific control variables, concentration (CONC) has a statistically significant and positive impact on bank productivity, implying that banks in less competitive markets experience higher bank TFP growth. The influence of financial development (CLAIMS) on bank productivity is negative but only statistically significant with all control variables included (column 5). Finally, GDP growth (GDPG) and inflation (INFA) are negatively related to bank productivity. Similar findings are reported in Delis et al. (2011).

Table 6-11 Financial Liberalisation and Total Factor Productivity

	Bank Specific	Regulation and Supervision	Market Structure & Financial Development	Macro-economic Conditions	All Controls
	(1)	(2)	(3)	(4)	(5)
FINLIB	0.0128	0.0139	0.0206*	0.0123	0.0280**
	(1.63)	(1.41)	(1.81)	(1.58)	(2.17)
ROE	0.197***	0.201***	0.194***	0.234***	0.226***
	(2.91)	(2.96)	(2.84)	(3.13)	(3.04)
EA	0.440	0.412	0.426	0.432	0.419
	(1.63)	(1.51)	(1.56)	(1.57)	(1.52)
LD	0.0220***	0.0222***	0.0223***	0.0225***	0.0227***
	(4.44)	(4.58)	(4.55)	(4.42)	(4.49)
SIZE	0.0125	0.000640	0.00554	0.00845	0.00554
	(0.97)	(0.04)	(0.36)	(0.59)	(0.35)
CAPR		0.00479			0.00299
		(1.02)			(0.63)
SUP		0.00411			0.00342
		(1.17)			(1.00)
PRI		0.0114			0.0169**
		(1.46)			(2.16)
ACT		-0.0446*			-0.0452*
		(-1.80)			(-1.85)
CONC			0.0868*		0.0817*
			(1.91)		(1.74)
CLAIMS			-0.0166		-0.0775**
			(-0.46)		(-2.04)
GDPG				-0.00276*	-0.00361**
				(-1.66)	(-1.97)
INFLA				-0.00364**	-0.00356**
				(-2.22)	(-2.18)
_cons	0.823***	0.829***	0.826***	0.879***	0.850***
	(7.22)	(6.31)	(7.03)	(7.03)	(6.19)
N	3525	3525	3525	3525	3525
R^2	0.016	0.019	0.017	0.019	0.023

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

6.4 Conclusion

This chapter has investigated the impact of financial liberalisation on banks' technical efficiency and total factor productivity growth, using the non-parametric DEA and Malmquist methods to calculate technical efficiency and productivity growth respectively, combined with panel data regression to analyse the impact of financial liberalisation.

Concerning the relationship between financial liberalisation (both *de jure* and *de facto* measures) and banks' technical efficiency, the results show that financial liberalisation has a negative impact on pure technical efficiency but the effect on scale efficiency is insignificant. Thus overall technical efficiency is reduced under financial liberalisation. This finding is different from the findings of Hermes and Nhung (2010), who find a positive impact of financial liberalisation on technical efficiency of the Latin American banks. The possible explanation for the decrease in technical efficiency is increasing input waste that might result from adapting to new environments, using new technology and advanced new management skills associated with a greater of financial liberalisation. With regard to the split of countries into different groups, the results also confirm that the impact of financial liberalisation is negatively related to pure technical efficiency in all specifications. However the effects are statistically significant only in the high income and the upper-middle income group countries. Extending the analysis with regard to the six dimensions of financial liberalisation based on the dataset of Abaid et al (2008), the results show that only capital allocation liberalisation leads to an improvement in technical efficiency, whereas entry barrier liberalisation and privatization decrease the technical efficiency of banks. Other aspects of financial liberalisation do not yield significant impact on technical efficiency. In most cases, scale efficiency is unaffected under financial liberalisation, so the impact on overall technical efficiency is mainly due to the pure technical efficiency effect.

With regard to the relationship between financial liberalisation and total factor productivity growth, the results in most cases show that financial liberalisation does not have a statistically significant and robust impact on productivity growth. There is however a marginal positive impact which is statistically significant in 2 out of 5 specifications, including where all control factors are included together.

CHAPTER 7

ACCOUNTING FOR THE ROLE OF RISK AND INSTITUTIONAL QUALITY IN ESTIMATION OF BANK EFFICIENCY UNDER FINANCIAL LIBERALISATION

7.1 Introduction

This chapter extends the empirical investigation of the impact of financial liberalisation on bank efficiency by accounting explicitly for the role of default risk while controlling for institutional quality. Since the banking sector is subject to limited liability, banks are incentivised to take on excessive risk with high leverage and equity holdings (Stiglitz, 1972). The existence of government safety nets and deposit insurance scheme implies a source of moral hazard that induces risk taking behaviour.

The empirical analysis of chapters 5 and 6 show that financial liberalisation has a significant impact on bank efficiency. But, as previous studies have shown, financial liberalisation also induces banking crises (Detragiache and Demirgüç-Kunt, 1998; Angkinand et al., 2010) due to the excessive risk-taking of banks (Ranciere et al., 2006). Hence, excessive risk taking could be considered as a possible transmission mechanism through which financial liberalisation influences bank efficiency, since banks might undertake risky portfolios with higher returns; ultimately, this risk taking behaviour might have a Greater influence on banks' cost or profit efficiency. However, the tendency to undertake excessive risk might come at the cost of higher risk of bank failure. Hence, it is appropriate to consider the impact of default risk when assessing the impact of financial liberalisation on bank efficiency. Indeed, some of the recent studies have focused on investigating the relationship between risk and efficiency (Berger and DeYoung, 1997; Girardone et al., 2004; Altunbas et al., 2007; Fiordelisi et al., 2011). In particular, some of the studies use Granger causality techniques to analyse the

relationship between the cost, profit efficiency and risk (Berger and DeYoung, 1997; Fiordelisi et al., 2011). With regard to the impact of risk, the insolvency risk measure (z-score) has been widely used in many of the previous studies (Beck et al., 2009; Laeven and Levine, 2009; Liu et al., 2010; Horvath et al., 2012). On the other hand, some of the previous studies indicate that the existence of deposit insurance would generate the moral hazard problem, inducing bank managers to engage in excessive risk-taking behaviour resulting in the possibility of bank failures (Merton, 1977; Keeley, 1990; Beck, 2003; Hon Chu, 2011). Furthermore, there are a number of empirical studies which investigate the relationship between deposit insurance, risk taking and banking crises (Cordella and Yeyati, 2002; Demirgüç-Kunt and Detragiache, 2002; Nier and Baumann, 2006). Most of the empirical studies find that the existence of explicit deposit insurance schemes increases the likelihood of bank instability. However, there are few studies that directly analyse the impact of deposit insurance and risk on bank efficiency.

This chapter therefore takes account of the above considerations by extending the empirical analyses of the previous chapters as follows: firstly, it extends the analyses of Chapters 5 and 6 to provide cross-country evidence by accounting for the influence of country-specific deposit insurance schemes and bank level default risk in the estimation of bank efficiency.[25] Secondly, following Berger and DeYoung (1997) and Fiordelisi et al., (2011), it conducts dynamic panel data estimation and Granger causality analysis to identify the causal links in the transmission of effects between financial liberalisation, risk and efficiency.

The chapter is organized as follows. Section 2 introduces a brief theoretical background and previous literatures relating to deposit insurance, risk and bank efficiency. Section 3 presents the empirical analysis for cost and profit efficiency while Section 4 does the same for technical efficiency. Section 5 conducts panel data estimation and Granger causality analysis. Finally, section 6 concludes.

[25] In extending the analyses of Chapters 5 and 6, the focus will be on cost, profit and technical efficiency, while total factor productivity (TFP) is excluded as the results of TFP are mostly insignificant in chapter 6.

7.2 Theoretical background and discussion

7.2.1 Deposit insurance and risk[26]

There are two functions of deposit insurance. On one hand, deposit insurance scheme seeks to protect the "safety and soundness" of banks which serves to enhance banking system stability by protecting the interests of small savers. In this case, the deposit insurance scheme is considered as an important part of the regulation and supervision regime. On the other hand, the role of banks is to provide liquidity for deposit account holders and who are also the participants in capital market that make them potentially exposed to bank runs, since a large amount of assets cannot be liquidated in a short time if individual depositors suddenly intend to withdraw their deposits (Angkinand et al., 2010). Most of the depositors generally have less information about the banks. Such imperfect information might lead to "contagion" of bank runs. The existence of a deposit insurance scheme therefore decreases the risk of bank runs and eliminates the probability of excessive liquidation of bank loans (Diamond and Dybvig, 1983).

However, the existence of deposit insurance is also considered as the source of moral hazard inducing banks to engage in excessive risk taking. Due to limited liability of bank managers and shareholders, they have greater incentive to take excessive risk (by investing in high risk, high return projects), and overlook the prudent risk evaluation and risk management processes especially when the value of equity is low (Angkinand et al., 2010). Additionally, the deposit insurance scheme gives the confidence to the depositors that their money is safe in banks, protected by guarantee and, therefore, it decreases the depositors' incentive to monitor banks, especially the depositors who are the most likely to monitor the banks (Beck, 2003). As a result, the existence of deposit insurance may increase the possibility of systemic bank failures.

With regard to the moral hazard creating role of deposit insurance, the standard moral hazard problem needs to be mentioned: once a (loan or debt) contract is settled, the agent (i.e. borrower or stockholder) is more likely to invest in higher risk, higher return project that will increase its value but not the benefit of the other party to the contract. In the case of banks, deposit insurance would transfer the risk of equity holders to debt

[26] In addition to the theoretical background and discussion of this section, see also section 3.2.4 in Chapter 3 which discusses the evidence on deposit insurance and risk.

holders. A further extension of the moral hazard problem in the banking sector is called "too big to fail" (TBTF): if a countries' major bank fails, other banks rely upon and have close financial connection with this major bank may also collapse. This spillover effect might further lead to economic recession (Stern and Feldman, 2004) and more likelihood of banking crises. In this context, the deposit insurance scheme is considered as "TBTF" protection policy in order to mitigate the spillover effects of a large bank collapse and systemic risk. However, deposit insurance is not a panacea. It also creates the moral hazard problem. On the one hand, creditors of big banks who expect government to protect their loans have little incentive to monitor bank behaviour or to select relationships with banks that are prudent in their decisions. On the other hand, realising that they face reduced monitoring from creditors and knowing that the government will bail them out if they fail, big banks take excessively risky projects and generally act less responsibly than they would if they had to shoulder the full burden of their behaviour. The result is squandered resources and more of the behaviour that leads to bank failures in the first place. The more extensive the protection that government offers to uninsured creditors, the more massive the moral hazard problem it creates (Stern and Feldman, 2004).

7.2.2 Risk and efficiency[27]

With regard to the relationship between risk and efficiency, some of the studies have provided theoretical arguments and hypotheses for incorporating risk factors into the efficiency analysis. Berger and DeYoung (1997) introduce four hypotheses for the relationship between risk (non-performing loan) and bank efficiency: (i) the "bad management" hypothesis implies that low cost efficiency Granger-causes larger amounts of loan loss pro vision (implying deteriorating asset quality) because management fails to control operating costs, which immediately realises low cost efficiency suggesting that poor managerial practice causes an increase in loan loss provision after a lag. In badly managed banks, low levels of cost efficiency signal poor senior management quality. Poor managers do not adequately control or monitor operating expenses and loan

[27] In addition to the theoretical background and discussion of this section, see also section 3.3.4 in Chapter 3 which discusses the evidence on risk and efficiency.

portfolio management is weak. Specifically, so-called bad managers exhibit the following tendencies. They are not adept at credit scoring and select a relatively high proportion of investments with low or negative net present values; col-lateral is improperly valued; and customers are not sufficiently monitored in order to ensure compliance with the loan contract; (ii) the "skimping" hypothesis assumes that there is a trade-off between cost efficiency and future risk since banks intend to gain higher revenue, which has higher risks to pay off the higher possibility of loss. In this case, banks taking long-run profits may choose lower costs in the short run by skimping on resources to allocate on underwriting and monitoring loans; (iii) the "bad luck" hypothesis indicates that external events precipitate an increase in problem loans so that they increase the extra costs and managerial effort; and (iv) the "moral hazard" hypothesis suggests that bank managers have more incentive to take higher risk, especially if the level of bank capital is low. In this case, better capitalised banks have less moral hazard incentives (Jeitschko and Jeung, 2005) and are more intensive to have careful operating practices to reduce costs (Fiordelisi et al., 2011).

As the literature reviewed in Chapter 3 (section 3.3.4) suggests, a number of studies have investigated the relationship between risk and efficiency. However, there are relatively few studies concentrating on the relationship between deposit insurance, risk and bank efficiency. Additionally, most of the previous studies only employ non-performing loans as a proxy of bank risk; in contrast, the deposit insurance is more represented as the country-level risk. Hence, this chapter account explicitly for the influence of deposit insurance and its potential consequences on the default risk of banks while investigating the impact of financial liberalisation on bank efficiency. No previous study has accounted for the influence of deposit insurance and risk on bank efficiency, although Pasiouras et al. (2007) in their investigation of the impact of banking regulations on efficiency allow for the effect of deposit insurance dummy and find that it has an impact on banks' cost and profit efficiency but the strength of the relationship is found to depend on financial sector and institutional developments.

7.3 Cost and profit efficiency (SFA)

7.3.1 Empirical model, data and variables

For cost and profit efficiency, the chapter employs the Battese and Coelli (1995) model with the same output and input variables as before (see chapter 5, section 5.3). The three output variables: loans (Q_1), other earning assets (Q_2), non-interest income (Q_3). Three inputs variables: cost of loanable funds (W_1), estimated by the ratio of interest expense/ total deposits; cost of physical capital (W_2), measured by overhead expenses net of personnel expenses/book value of fixed assets; and cost of labour (W_3), defined as personnel expenses/total assets. In addition, the equity is considered as quasi-fixed input (E) in the cost and profit function to control the different level of banks' risk preferences (see chapter 5 section 5.3.2).

Empirical estimation model

$$\ln\left(\frac{TC_{it}}{w_3}\right) = \beta_0 + \beta_1 \ln(Q1) + \beta_2 \ln(Q2) + \beta_3 \ln(Q3) + \beta_4 \ln\left(\frac{W_1}{W_3}\right) + \beta_5 \ln\left(\frac{W_2}{W_3}\right) + \beta_6 \frac{1}{2}\left(\ln(Q1)\right)^2$$
$$+ \beta_7 \ln(Q1)\ln(Q2) + \beta_8 \ln(Q1)\ln(Q3) + \beta_9 \frac{1}{2}\left(\ln(Q2)\right)^2 + \beta_{10} \ln(Q2)\ln(Q3)$$
$$+ \beta_{11} \frac{1}{2}\left(\ln(Q3)\right)^2 + \beta_{12} \frac{1}{2}\left(\ln\left(\frac{W_1}{W_3}\right)\right)^2 + \beta_{13} \ln(Q1)\left(\frac{W_1}{W_3}\right) + \beta_{14} \ln(Q2)\ln\left(\frac{W_1}{W_3}\right)$$
$$+ \beta_{15} \ln(Q3)\ln\left(\frac{W_1}{W_3}\right) + \beta_{16} \frac{1}{2}\left(\ln\left(\frac{W_2}{W_3}\right)\right)^2 + \beta_{17} \ln(Q1)\ln\left(\frac{W_2}{W_3}\right) + \beta_{18} \ln(Q2)\ln\left(\frac{W_2}{W_3}\right)$$
$$+ \beta_{19} \ln(Q3)\ln\left(\frac{W_2}{W_3}\right) + \beta_{20} \ln\left(\frac{W_1}{W_3}\right)\ln\left(\frac{W_2}{W_3}\right) + \beta_{21} T + \beta_{22} \frac{1}{2} T^2 + \beta_{23} T \ln(Q1)$$
$$+ \beta_{24} T \ln(Q2) + \beta_{25} T \ln(Q3) + \beta_{26} T \ln\left(\frac{W_1}{W_3}\right) + \beta_{27} T \ln\left(\frac{W_2}{W_3}\right) + \beta_{28} \ln(E) + \beta_{29} \frac{1}{2} \ln(E)^2$$
$$+ \beta_{30} \ln(E)\ln(Q1) + \beta_{31} \ln(E)\ln(Q2) + \beta_{32} \ln(E)\ln(Q3) + \beta_{33} \ln(E)\ln\left(\frac{W_1}{W_3}\right)$$
$$+ \beta_{34} \ln(E)\ln\left(\frac{W_2}{W_3}\right) + \beta_{35} D_{HIGH} + \beta_{36} D_{UPPH} + \beta_{37} D_{LOWMID} + v_{it} + u_{it}$$

Potential Determinant of inefficiency

In order to examine the impact of the deposit insurance scheme variables on the efficiency of banks, at the same time, controlling for intuitional quality variables and other country-specific variables, the mean inefficiency m_{it} is now represented by:

$$\begin{aligned} m_{it} = {} & \delta_0 + \delta_1 FINLIB_{it} + \delta_2 CAPR_{it} + \delta_3 SUP_{it} + \delta_4 PRIM_{it} + \delta_5 ACT_{it} + \delta_6 CONC_{it} \\ & + \delta_7 CLAIM_{it} + \delta_8 GDPGR_{it} + \delta_9 INFA_{it} + \delta_{10} HIGH_{it} + \delta_{11} UPPM_{it} + \delta_{12} LOWMID_{it} \\ & + \delta_{13} DEPIN_{it} + \delta_{14} DEPOWER_{it} + \delta_{15} MORAL_{it} + \delta_{16} LEGAL_{it} + \delta_{17} POLIT_{it} \\ & + \delta_{18} ECON_{it} + \delta_{19} Z - score_{itc} \end{aligned}$$

where *FINLIB, , SUP, PRIM, ACT, CONC, CLAIM, GDPGR, INFA, HIGH, UPPM, LOWMID* are the same in chapter 5 (see more detail in chapter 5, appendix 5.B); *DEPIN* is a deposit insurance dummy variable, *DEPOWER* refers to deposit insurer power, *MORAL* is moral hazard index, *LEGAL, POLIT, ECON* are legal, political and economic institutional quality variables respectively, and *Z – score* refers to possibility of default risk (insolvency risk) of bank *c* in country *i* at time *t*. More specific details are discussed below.

Deposit insurance scheme variables

Three variables which capture the deposit insurance scheme are: (a) *DAPIN* is a dummy variable to capture whether a country has the explicit deposit insurance or not, equals 1 if the country has explicit deposit insurance, otherwise 0; (b) *DEPOWER* (Deposit Insurer Power) is an aggregate index of whether the deposit insurance authority has the power or authority based on the three questions (as followed by Barth et al. (2004)) with reference to the 2001, 2003 and 2008 versions of the database of Barth et al. (2001): (1) to make the decision to intervene in a bank, (2) to take legal action against bank directors or officials, or (3) has ever taken any legal action against bank directors or officers. The sum of the assigned values ranges from 0 to 3, with higher values indicating more power; (c) *MORAL* (the Moral Hazard Index), is an aggregate index of deposit insurance systems followed eight questions as Carkovic and Levine (2002): no coinsurance, foreign currency deposits covered, interbank deposits covered, type of funding, source of funding, management, membership, and the level of explicit coverage. Higher values imply greater moral hazard.

Default Risk

Z-score is used as a proxy of bank-level default risk that is generally employed as proxy of the probability of failure of banks, since it reflects both asset risk and equity capital cushion (Beck et al., 2009; Laeven and Levine, 2009; Liu et al., 2010; Horvath et al., 2012). Measurement of z-score is defined as follows:

$$Z = \frac{ROA + E/A}{\sigma(ROA)} = \frac{ROA + CAR}{\sigma(ROA)}$$

where ROA is return on asset (measuring for the bank performance), $\sigma(ROA)$ is standard deviation of return on asset (measuring the bank risk), and E/A is equity to total assets ratio (measuring leverage risk which reflects safe and soundness of banks). A higher Z indicates that a bank is farther from insolvency. Since Z is highly skewed, we use its natural logarithm, which is normally distributed (Laeven and Levine, 2009; Liu et al. 2010).

Institutional Quality Related Variables

There are three institutional quality control variables are constructed by Kuncic (2012), capturing the three aspects of institutional environment based on factor analysis of each variable separately (see more details in table of Appendix 7.A): legal institutional environment (*LEGAL*), political institutional environment (*POLIT*) and economic institutional environment (*ECON*) all ranging from 0 to 1 (standardized factor score), however the scale is inversed so that the higher value indicates the lower quality of legal, political and economic environment. More specifically, Kuncic (2012) indicates that legal institutions issues involve property rights, the origins of legal systems and their effects and enforcement of legal institutions; quality of political institutions involve the voting rights and electoral rules, political parties and rules of and limits of a government or state; quality of economic institutions involve enforcement of property rights, regulations etc. Lensink et al. (2008) emphasise the impact of institutional quality on the foreign bank efficiency and suggest that it is important for well-developed institutions, no matter in the host or home country, for efficient operation of foreign banks. Chen (2009) investigates bank efficiency in Sub-Saharan African Middle-Income countries and indicates that strong legal rights and contract laws, and better governance, including political stability

and government effectiveness have a positive impact on efficiency. Angkinand et al. (2010) indicate that strong regulation and supervision power and higher quality of legal and political institutions weaken the linkage between financial liberalisation and banking crises. In this case, higher quality of legal and political institutions reduces the potential for excessive risk which might influence the efficiency of banks.

Regulation, Supervision and Financial liberalisation variables

There are four variables used to control for differences in banking regulations across countries and these are based on the 2001, 2003 and 2008 versions of the database originally provided by Barth et al (2001). As in Pasiouras et al. (2009), the chapter uses the capital requirements index (*CAPR*), the index of official supervisory power (*SUP*), the index of private monitoring (*PRIM*), and the index of level bank activities restrictiveness (*ACT*). Three of these measures (*CAPR, SUP, PRIM*) are related to the three pillars of Basel II: capital requirements (first pillar), official supervisory power (second pillar), and market discipline (third pillar) (Basel Committee on Banking Supervision, 2004).

This chapter employs the *de jure* index of *FINLIB* to represent the effect of financial liberalisation, as constructed by (Chinn and Ito 2008) to capture the intensity of capital market liberalisation. Maysami and Sakellariou (2008) find that deposit insurance would alleviate moral hazard and increase stability in banking sector only if a sufficient degree of financial liberalisation exists.

Other country-level control variables

There are two variables, *CONC* and *CLAIM*, used to control for the financial development and market structure: *CONC* measures bank concentration that is defined as a ratio of the total assets of three largest commercial banks to the total assets of all commercial banks of a country. This variable indirectly controls for the degree of competition of the banking industry, with a higher value implying less competition (more concentration). *CLAIM* is the ratio of claims on the private sector to GDP that captures the depth of financial intermediation. The higher ratio indicates higher level of bank activities in the economy. *GDPGR* is the real GDP growth rate. *INFA* is the annual

inflation rate. These two variables are used to control the macroeconomic environment as in Grigorian and Manole (2002) and Pasiouras et al. (2009). The three dummy variables (*HIGH, UPPM* and *LOWMID)*, which represent higher, upper-middle, lower-middle income group countries, are used to distinguish the effect of these income-group countries against low income group of countries (which represent the base case), These three dummy variables effectively capture the effect of different levels of economic development (Lozano-Vivas and Pasiouras, 2010).

7.3.2 Empirical results

7.3.2.1 Cost and profit efficiency scores using global frontier

Table 7-1 presents the results of cost and profit efficiency scores using the global frontier, distinguished by year, geographical region, and income group level in Panels A, B and C separately.

Table 7-1 Basic cost and profit efficiency estimation

	Number of observations	Cost efficiency		Profit efficiency	
		Mean	Std. Dev	Mean	Std. Dev
Panel A: mean by year					
2000	756	0.8758	0.0835	0.5954	0.1646
2001	816	0.8689	0.0931	0.5825	0.1617
2002	865	0.8700	0.0927	0.6041	0.1496
2003	954	0.8759	0.0944	0.6063	0.1544
2004	1121	0.8753	0.0902	0.6065	0.1536
2005	1284	0.8830	0.0819	0.6264	0.1354
2006	1339	0.8858	0.0780	0.6156	0.1378
2007	1318	0.8822	0.0863	0.5661	0.1678
2008	1248	0.8798	0.0847	0.5399	0.1844
2009	1206	0.8822	0.0777	0.4016	0.2636
Panel B: mean by geographical region					
Asia Pacific	2118	0.8701	0.0910	0.6222	0.1689
Australasia	68	0.8874	0.0391	0.5325	0.1573
Eastern Europe	1283	0.8772	0.0610	0.5849	0.1973
Latin America	1950	0.8540	0.1156	0.5416	0.1788
Middle East and Africa	1266	0.8784	0.0739	0.6285	0.1611
North America	128	0.8760	0.0569	0.5139	0.1601
Western Europe	4094	0.8956	0.0735	0.5416	0.1868
Panel C: mean by country group					

High income	5375	0.8896	0.0737	0.5520	0.1913
Upper middle income	2922	0.8691	0.0676	0.5781	0.1524
Lower middle income	2106	0.8621	0.1056	0.6009	0.1674
Low income	504	0.8897	0.0676	0.6305	0.1524
Overall mean	10907	0.8788	0.0859	0.5720	0.1839

Note: The means value by year, geographical region and income country group.

The mean of cost efficiency is 0.8787, while profit efficiency is 0.5720. Thus, the results imply that, on average, banks could improve cost efficiency by 12.13% and profit efficiency by 42.8% relative to the best-performance bank. In this case, the results show that banks experience more profit inefficiency than cost inefficiency, confirming the previous findings of (Maudos et al., 2002; Pasiouras et al., 2009). Moreover, the results are also consistent with the argument that the most cost-efficient banks are not necessarily the most profit-efficient banks, and vice versa (Berger and Mester, 1997; Rogers, 1998; Maudos et al., 2002; Pasiouras et al., 2009). The cost efficiency score in our estimation period does not fluctuate so much, being roughly stable around 0.87, while the profit efficiency score sharply declined from 0.6152 to 0.5661 during the financial crisis in 2007-09. In addition, the results show that most cost efficient regions or income group countries are not also the most profit-efficient ones.

7.3.2.2 Potential correlates of cost and profit efficiency

Table 7-2 shows the impact of the deposit insurance scheme and other country-specific control variables on bank inefficiency. Columns 1 and 2 show the estimation results on cost inefficiency and profit inefficiency respectively.

Concerning the impact of deposit insurance variables (*DEPIN*, *DEPOWER*, and *MORAL*) on banks' cost and profit inefficiency, the results show that *DEPIN* and *DEPOWER* are statistically significant and positively related to both cost and profit inefficiency. The results imply that the explicit deposit insurance and higher degree of deposit insurer power decreases both cost and profit efficiency. The results might be explained by the argument that stricter regulation and supervision might reduce bank efficiency (Levine, 2005), since explicit deposit insurance and higher deposit insurer power are part of the regulation scheme. Strengthening regulatory and supervisory power might also lead to corruption (Levine, 2005). On the other hand, the results show that

MORAL is statistically significant and negatively related to both cost and profit inefficiency, which implies that the greater moral hazard improves profit and cost efficiency in the banking sector. Regarding the impact of default risk (z-score), the result shows that it is statistically significant and negatively related to cost and profit inefficiency, implying that the higher the risk of bank failure (default risk), the lower the cost and profit efficiency of banks. The results are partially consistent with the conventional "*bad management*" hypothesis that a higher incentive of risk behaviour lowers efficiency of banks (Berger and DeYoung, 1997). However, the results of *MORAL* are supported by "*revival*", "*luck*" and "*luck moral hazard*" hypotheses suggested by Fiordelisi et al. (2009): the "*revival*" hypothesis suggests that exogenous risk-taking temporally precedes cost efficiency improvement, since banks might intend to cut waste by recognising the possible further problem; the "*luck*" hypothesis and "*luck moral hazard*" hypothesis are similar, suggesting that risk-taking might temporally increase revenue efficiency due to extra income from a higher interest rate on the lower-quality loans.

With regard to the impact of institutional quality, legal institutional quality is statistically significant and positively related to cost and profit inefficiency[28], with the result implying that higher legal institutional quality improves bank efficiency. It is consistent with the finding of Lensink et al. (2008). On the other hand, the variable economic institutional quality is statistically significant and negatively related to cost and profit inefficiency, which implies that higher economic institutional quality decreases bank efficiency. In this case, based on the study of Kuncic (2012), the economic institutional quality index reflects regulation quality, so the higher economic institutional quality might reflect the stricter regulation policies that may decrease bank efficiency (Levine (2005). In addition, the result of political institutional quality is shown to be statistically significant and negative with cost inefficiency but positive with profit inefficiency, which implies that the higher political institutional quality lowers cost efficiency but increases profit efficiency.

[28] All institutional variables are scaled inversed, and the higher value refers to the lower quality of the institution.

Concerning the impact of financial liberalisation, regulation and supervision variables on banks' cost and profit efficiency, all coefficients of these variables are statistically significant and in line with the results in Chapter 5. Turning to the impact of environment variables, most results are also consistent with the results in Chapter 5. However, financial development (*CLAIM*) negatively influences cost efficiency and positively influences profit efficiency (only significant at 10%), which seems to suggest that the impact of financial development on banks' cost and profit efficiency could depend on other control variables such as the quality of the institution. In addition, there is a negative impact of *GDPG* on cost efficiency but a positive impact on profit efficiency; the inflation rate has a negative influence on both bank profit and cost efficiency.

Table 7-2 Determinants of cost and profit inefficiency

	Cost inefficiency	**Profit inefficiency**
Constant	-3.5897***	-3.3559**
	(0.8089)	(1.0575)
FINLIB	0.2669***	-0.0276***
	(0.0591)	(0.0050)
CAPR	-0.3121***	0.0135**
	(0.0706)	(0.0044)
SUP	0.1718***	-0.0221***
	(0.0385)	(0.0048)
PRIM	0.3522***	0.0941**
	(0.0792)	(0.0305)
ACT	-0.6301***	0.1736**
	(0.1411)	(0.0546)
CONC	-2.5699***	0.4036**
	(0.5795)	(0.1289)
CLAIM	0.0337***	-0.0844*
	(0.0084)	(0.0368)
GDPGR	0.0027***	-0.0328***
	(0.0006)	(0.0084)
INFA	0.0862***	0.0092**
	(0.0193)	(0.0035)
HIGH	0.3669***	0.3052***
	(0.0882)	(0.0558)
UPPH	0.4666***	0.3226***
	(0.1084)	(0.0623)
LOWMID	1.8070***	0.2608***
	(0.4103)	(0.0442)
DEPIN	0.3896***	0.2614*
	(0.0892)	(0.1082)

DEPOWER	0.2623***	0.1227***
	(0.0591)	(0.0336)
MORAL	-0.4766***	-0.0483**
	(0.1074)	(0.0184)
LEGAL	5.2714***	0.6151***
	(1.1802)	(0.1837)
POLIT	-1.6467***	1.6672**
	(0.3703)	(0.5549)
ECON	-6.0777***	-1.7039***
	(1.3590)	(0.5036)
Z-score	-0.6931***	-0.0704***
	(0.1565)	(0.0189)

Note: Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10%.

7.3.3 Specific frontier analysis

Table 7-3 and Table 7-4 show the impact of the deposit insurance scheme, risk and other control variables on banks' cost and profit inefficiency based on different income group frontier estimation. We concentrate on discussing the impact of the deposit insurance scheme and risk variables. *DEPIN* is statistically significant and positively related to cost inefficiency in the high income and upper-middle income group countries, while it is positively related to profit inefficiency in high, upper-middle, and lower-middle income group countries. The result implies that the explicit deposit insurance system, on average, decreases bank efficiency in high and advanced income level countries. These results are consistent with the results using global frontier analysis. However, the variable *DEPIN* has no statistically significant impact on cost and profit inefficiency in lower income group countries. Regarding the variable *DEPOWER*, representing the degree of deposit insurer power, it positively relates to cost inefficiency in high income and lower-middle income group countries, but it has a negative impact in upper-middle and lower income countries (all statistically significant). The results imply that in upper-middle and lower income group countries, the higher deposit insurer power improves cost efficiency. On the other hand, it has a positive impact on profit inefficiency in the high income and upper-middle income group. The variable *MORAL* is statistically significant and negatively related to cost inefficiency in high and advanced income group countries, while it does not have a statistically significant impact in lower income group countries. Concerning the impact on profit inefficiency, the results show that *MORAL* has a positive impact on profit inefficiency in the high income group. In upper-middle and

lower-middle income group countries, it has a negative impact on profit inefficiency. The result implies that the higher moral hazard decreases profit efficiency in high income countries, but improves the profit efficiency in upper-middle and middle-lower income group countries. Concerning the result of *Z-score*, representing the possibility of default risk, is negative and statistically significant related to both cost and profit inefficiency in all various levels of income group countries. The results imply that the higher possible insolvency risks of banks have lower efficiency and the results are consistent with the results of global frontier estimation.

Table 7-3 Potential determinants on cost inefficiencies (income group region frontier)

	High Income	Upper & Middle Income	Middle & Lower Income	Lower Income
Constant	-2.6933***	-20.0070**	-2.6448**	-0.1319
	(1.6950)	(9.8526)	(1.1055)	(0.9016)
FINLIB	0.0555*	-0.6261**	0.5568***	0.2487**
	(0.0287)	(0.3056)	(0.1527)	(0.1186)
CAPR	0.1830**	-0.3113**	-0.2729**	-0.1295***
	(0.0775)	(0.1509)	(0.1128)	(0.0426)
SUP	0.0902***	0.3830**	-0.0609	0.0097
	(0.0343)	(0.1876)	(0.0726)	(0.0227)
PRIM	0.8337**	0.4249**	0.9581***	0.3432***
	(0.3570)	(0.2132)	(0.1882)	(0.0774)
ACT	-2.4304***	1.3752**	-0.7938***	-0.0802
	(0.8781)	(0.6767)	(0.2743)	(0.1880)
CONC	-2.8222***	9.0194**	-0.5481	-0.1881
	(1.0851)	(4.4041)	(1.0293)	(0.2396)
CLAIM	-1.6850***	2.5318**	-0.3889	-0.4154
	(0.6443)	(1.2371)	(1.2699)	(0.8920)
GDPGR	0.0852***	-0.0265**	0.1265***	-0.0002
	(0.0316)	(0.0125)	(0.0374)	(0.0050)
INFA	0.1515***	0.0887**	-0.1862***	0.0039
	(0.0586)	(0.0437)	(0.0355)	(0.0045)
DEPIN	4.0514**	4.2759**	0.0807	0.5381
	(1.5901)	(2.0937)	(0.8812)	(0.4139)
DEPOWER	0.3875***	-1.7265**	1.2689***	-0.8949***
	(0.1449)	(0.8499)	(0.2048)	(0.3401)
MORAL	-0.4697***	-1.4173**	-0.4013***	0.0320
	(0.1737)	(0.6911)	(0.1552)	(0.0701)
LEGAL	0.9223	-7.2497**	8.8873***	0.6791
	(0.8066)	(3.5253)	(3.2335)	(0.4624)
POLIT	-2.8663***	-4.5133**	-5.2285***	-0.4385
	(1.0992)	(2.1984)	(1.8974)	(0.4147)
ECON	-3.3745**	6.6330**	-4.9667*	-0.9305**
	(1.7070)	(3.2244)	(2.7605)	(0.4215)

Z-score	-0.8900***	-0.5390**	-0.6881***	-0.0437***
	(0.3179)	(0.2654)	(0.1420)	(0.0168)

Note: Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level.

Table 7-4 Potential determinants on profit inefficiencies (income group region frontier)

	High Income	Upper & Middle Income	Middle & Lower Income	Lower Income
Constant	-8.4521***	-0.8279**	-17.6371***	-3.9323
	(2.7971)	(0.3752)	(5.6734)	(3.4453)
FINLIB	-0.6374***	-0.0081	1.2898***	1.0072
	(0.2052)	(0.0052)	(0.4027)	(0.7331)
CAPR	-0.0843***	0.0179**	0.4743**	-0.3044
	(0.0273)	(0.0080)	(0.2069)	(0.2644)
SUP	-0.2399***	-0.0031	0.7920***	0.0146
	(0.0780)	(0.0029)	(0.2030)	(0.0587)
PRIM	0.5053***	0.0265**	-0.1651	0.3483
	(0.1668)	(0.0116)	(0.2038)	(0.2799)
ACT	0.4070***	0.1103**	-1.3890***	0.1254
	(0.1355)	(0.0472)	(0.4547)	(0.3673)
CONC	1.9233***	0.1982**	-0.7613	0.9501
	(0.6172)	(0.0949)	(0.9205)	(0.8486)
CLAIM	0.9289***	-0.2034**	7.6697***	3.7111
	(0.3065)	(0.0851)	(2.1763)	(3.1949)
GDPGR	-0.2947***	-0.0150***	-0.2161***	0.0466
	(0.0955)	(0.0058)	(0.0667)	(0.0466)
INFA	0.1931***	-0.0053**	0.0015	0.0458
	(0.0646)	(0.0022)	(0.0318)	(0.0316)
DEPIN	0.6599***	0.1483**	2.9102**	2.0433
	(0.2160)	(0.0666)	(1.1647)	(1.3879)
DEPOWER	0.4087***	0.0300*	0.1444	-1.6806
	(0.1341)	(0.0159)	(0.2237)	(1.2925)
MORAL	0.3839***	-0.0790**	-0.5669**	-0.1276
	(0.1263)	(0.0316)	(0.2538)	(0.1489)
LEGAL	10.3810***	0.3486***	-15.7254**	-1.0388
	(3.3698)	(0.0698)	(6.9142)	(1.8416)
POLIT	0.4356***	0.3444**	17.0241***	3.8391
	(0.1555)	(0.1706)	(4.8865)	(3.1503)
ECON	-12.9260***	-0.7280***	5.5720	-0.2228
	(4.2135)	(0.1879)	(5.2751)	(1.4703)
Z-score	-0.1899***	-0.0303***	-0.9869***	-0.1132**
	(0.0621)	(0.0105)	(0.2724)	(0.0541)

Note: Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level.

7.4 Technical efficiency (DEA)

7.4.1 Empirical model, data and variables

As in chapter 6, for technical efficiency this chapter employs two-stage Data Envelopment Analysis (DEA). For the first stage, the efficiency scores (overall technical efficiency, pure technical efficiency and scale efficiency) are the same as obtained in Chapter 6 since all the input and output variables are the same.

The second step is designed to test the impact of financial liberalisation, deposit insurance and risk on banks' technical efficiency, so the estimated regression is specified as:

$$Y_{itc} = \alpha_0 + \alpha_1 FINLIB_{tc} + \alpha_2 DEP_{tc} + \alpha_3 RISK_{itc} + \alpha_2 Z_{itc} + u$$

where Y is a vector of efficiency scores for country c at time t; $FINLIB$ is the proxy for financial liberalisation in country c at time t; DEP is the deposit insurance scheme for country c at time t; $RISK$ is the measure of default risk for bank i in country c at time t; Z is a set of other control variables which include bank-specific variables and country-specific variables; and u is the random error term.

The regression is estimated on panel data from 2000 to 2009, using the panel least square fixed effects model, after employing the Hausman Test which confirms that the fixed effects model is preferred over the random effect model.

7.4.2 Empirical results

Table 7-5 to Table 7-7 present the results of the impact of the deposit insurance variables and risk on banks' overall technical efficiency, pure technical efficiency, and scale efficiency respectively, with each table having six columns representing different model specifications. All columns are controlled for bank-specific variables. Column [1] controls for bank-level-specific variables only; column [2] adds the financial liberalisation and regulation variables; column [3] adds market structure, column [4] adds the macro-economic variables; column [5] adds institutional quality variables; and column [6] controls for all the variables.

Table 7-5 shows the impact of the DEPIN, DPOWER, MORAL and Z-score on overall technical efficiency assuming constant returns to scale. The results from column [1] to column [4] are statistically significant and positively relate to overall technical

efficiency, but while adding institutional quality variables and controlling all bank-level and country-level-specific variables, the results are still positively related to overall technical efficiency but not statistically significant. These results imply that deposit insurance might improve technical efficiency of banks; however, the results are not robust and might be influenced by other control variables. On the other hand, variables MORAL and Z-score are statistically significant and negatively relate to overall technical efficiency in all columns. This might be explained by the "*moral hazard*" hypothesis that well-capitalised banks have less inclination to take on risk and operate more efficiency, and the "*luck*" hypothesis that increasing incentive of risk-taking might temporally increase efficiency.

Table 7-6 presents the results on pure technical efficiency, showing that only Z-score and DPOWER are statistically significant and negatively related to pure technical efficiency.

Table 7-7 presents the results on scale efficiency. Here, none of deposit insurance variables are statistically significant, except DPOWER which is negatively related to scale efficiency in columns [1] to [5].

Regarding the impact of the institutional quality variables, LEGAL is statistically significant and positively relates to overall technical efficiency, pure technical efficiency and scale efficiency. ECON is statistically significant and negatively related to all types of efficiency. Finally, POLIC improves mainly the scale efficiency of banks.

Table 7-5 Deposit Insurance, Risk and Overall Technical Efficiency

	Bank Specific	Liberalisation Regulation & Supervision	Market Structure	Macro-economic Condition	Institutional Quality	All control
	(1)	(2)	(3)	(4)	(5)	(6)
DEPIN	0.0383***	0.0282**	0.0345***	0.0237*	0.0107	-0.0179
	(2.99)	(2.23)	(2.60)	(1.79)	(0.80)	(-1.28)
DEPOWER	-0.0166***	-0.00681**	-0.0150***	-0.0150***	-0.0143***	0.000875
	(-5.21)	(-2.25)	(-4.72)	(-4.68)	(-4.44)	(0.28)
MORAL	-0.00702**	-0.00731**	-0.00716**	-0.00614**	-0.00730**	-0.00583**
	(-2.41)	(-2.47)	(-2.45)	(-2.14)	(-2.46)	(-2.03)
Z-score	-0.0119*	-0.0112*	-0.0126*	-0.0132**	-0.0116*	-0.0138**
	(-1.84)	(-1.73)	(-1.95)	(-2.05)	(-1.82)	(-2.20)
EA	-0.131*	-0.108	-0.123*	-0.130*	-0.109	-0.0759
	(-1.87)	(-1.54)	(-1.75)	(-1.85)	(-1.59)	(-1.12)
SIZE	-0.0264***	-0.0208***	-0.0255***	-0.0238***	-0.0222***	-0.0131***
	(-8.32)	(-6.64)	(-7.95)	(-7.53)	(-6.85)	(-4.14)
ROE	0.0489**	0.0452**	0.0453**	0.0538**	0.0479**	0.0409*
	(2.08)	(1.98)	(1.96)	(2.22)	(2.07)	(1.86)
LD	0.00460**	0.00440**	0.00460**	0.00465**	0.00458**	0.00445**
	(2.39)	(2.14)	(2.38)	(2.37)	(2.32)	(2.09)
FINLIB		-0.0257***				-0.0244***
		(-7.98)				(-7.23)
CAPR		-0.000792				-0.00226
		(-0.44)				(-1.24)
SUP		0.00330**				0.00208
		(2.41)				(1.53)
PRI		0.00219				0.00435
		(0.63)				(1.18)
ACT		-0.0954***				-0.0952***
		(-11.22)				(-11.42)
CONC			-0.0532***			-0.122***
			(-3.10)			(-6.03)
CLAIMS			0.00621			-0.0322
			(0.30)			(-1.49)
INFLA				-0.00137***		-0.00103**
				(-3.12)		(-2.05)
GDPG				-0.00459***		-0.00469***
				(-8.90)		(-8.81)
LEGAL					0.360***	0.248***
					(8.18)	(5.61)
POLIC					-0.0658	0.172***
					(-1.45)	(3.67)
ECON					-0.408***	-0.310***
					(-9.73)	(-7.51)
_cons	0.558***	0.728***	0.591***	0.572***	0.611***	0.769***
	(17.33)	(18.53)	(17.48)	(17.99)	(14.66)	(17.09)
N	10907	10907	10907	10907	10907	10907

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

Table 7-6 Deposit Insurance, Risk and Pure Technical Efficiency

	Bank Specific	Liberalisation Regulation & Supervision	Market Structure	Macro-economic Condition	Institutional Quality	All control
	(1)	(2)	(3)	(4)	(5)	(6)
DEPIN	0.0305*	0.0214	0.0273	0.0119	0.00146	-0.0235
	(1.65)	(1.14)	(1.45)	(0.63)	(0.08)	(-1.20)
DEPOWER	-0.0103**	-0.00269	-0.00981**	-0.00824**	-0.00803**	0.00431
	(-2.58)	(-0.69)	(-2.44)	(-2.05)	(-2.00)	(1.07)
MORAL	-0.00547	-0.00561	-0.00562	-0.00436	-0.00290	-0.00425
	(-1.49)	(-1.51)	(-1.53)	(-1.20)	(-0.78)	(-1.15)
Z-score	-0.0186**	-0.0180**	-0.0190**	-0.0202**	-0.0183**	-0.0205**
	(-2.16)	(-2.08)	(-2.22)	(-2.35)	(-2.13)	(-2.40)
EA	0.142**	0.162**	0.145**	0.144**	0.163**	0.189***
	(2.12)	(2.36)	(2.17)	(2.15)	(2.45)	(2.79)
SIZE	-0.0561***	-0.0515***	-0.0558***	-0.0527***	-0.0519***	-0.0441***
	(-10.66)	(-9.70)	(-10.45)	(-10.05)	(-9.71)	(-8.16)
ROE	0.0482	0.0450	0.0470	0.0542	0.0473	0.0439
	(1.44)	(1.37)	(1.41)	(1.58)	(1.42)	(1.35)
LD	0.00264***	0.00248***	0.00265***	0.00270***	0.00263***	0.00257***
	(4.53)	(3.67)	(4.49)	(4.33)	(4.34)	(3.42)
FINLIB		-0.0230***				-0.0252***
		(-4.62)				(-4.79)
CAPR		-0.000820				-0.00240
		(-0.36)				(-1.06)
SUP		0.00307				0.00155
		(1.58)				(0.79)
PRI		-0.000396				0.00151
		(-0.09)				(0.34)
ACT		-0.0748***				-0.0734***
		(-7.05)				(-7.07)
CONC			-0.0274			-0.0999***
			(-1.22)			(-3.88)
CLAIMS			0.0427			0.00922
			(1.52)			(0.32)
INFLA				-0.00190***		-0.00176***
				(-3.20)		(-2.70)
GDPG				-0.00579***		-0.00624***
				(-7.97)		(-7.83)
LEGAL					0.340***	0.252***
					(6.07)	(4.39)
POLIC					-0.0284	0.188***
					(-0.45)	(2.90)
ECON					-0.397***	-0.291***
					(-7.31)	(-5.26)
_cons	0.929***	1.073***	0.924***	0.947***	0.964***	1.065***
	(19.20)	(19.33)	(18.97)	(19.74)	(16.77)	(17.04)
N	10907	10907	10907	10907	10907	10907

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

Table 7-7 Deposit Insurance, Risk and Scale Efficiency

	Bank Specific	Liberalisation Regulation & Supervision	Market Structure	Macro-economic Condition	Institutional Quality	All control
	(1)	(2)	(3)	(4)	(5)	(6)
DEPIN	-0.00187	0.00125	-0.00131	0.000615	-0.00638	-0.00499
	(-0.13)	(0.09)	(-0.09)	(0.04)	(-0.45)	(-0.34)
DEPOWER	-0.00804***	-0.00677**	-0.00781**	-0.00828***	-0.00776**	-0.00510
	(-2.59)	(-2.20)	(-2.52)	(-2.66)	(-2.49)	(-1.62)
MORAL	0.00198	0.00170	0.00202	0.00182	0.00114	0.000990
	(0.75)	(0.64)	(0.76)	(0.69)	(0.43)	(0.37)
Z-score	0.00532	0.00540	0.00533	0.00566	0.00568	0.00600
	(0.86)	(0.87)	(0.86)	(0.91)	(0.92)	(0.98)
EA	-0.0690	-0.0691	-0.0680	-0.0682	-0.0682	-0.0620
	(-1.06)	(-1.06)	(-1.04)	(-1.05)	(-1.05)	(-0.95)
SIZE	0.0391***	0.0395***	0.0392***	0.0386***	0.0391***	0.0401***
	(9.88)	(9.69)	(9.79)	(9.69)	(9.69)	(9.50)
ROE	0.0264	0.0253	0.0259	0.0252	0.0262	0.0217
	(1.51)	(1.43)	(1.49)	(1.44)	(1.51)	(1.23)
LD	0.00125*	0.00125*	0.00125*	0.00124*	0.00130*	0.00125*
	(1.80)	(1.81)	(1.80)	(1.81)	(1.91)	(1.90)
FINLIB		-0.00515				-0.00579
		(-1.19)				(-1.32)
CAPR		-0.00154				-0.00154
		(-0.87)				(-0.88)
SUP		0.00203				0.00131
		(1.39)				(0.89)
PRI		0.00986***				0.0108***
		(3.20)				(3.50)
ACT		-0.00830				-0.0146*
		(-0.99)				(-1.78)
CONC			-0.00185			-0.0186
			(-0.12)			(-1.12)
CLAIMS			-0.0209			-0.0406*
			(-0.99)			(-1.82)
INFLA				0.0000342		0.000334
				(0.07)		(0.69)
GDPG				0.000863		0.00143**
				(1.44)		(2.03)
LEGAL					0.103**	0.0810*
					(2.41)	(1.84)
POLIC					0.177***	0.198***
					(4.36)	(4.69)
ECON					-0.107**	-0.112**
					(-2.53)	(-2.57)
_cons	0.485***	0.432***	0.498***	0.483***	0.380***	0.373***
	(13.58)	(10.53)	(13.60)	(13.57)	(9.50)	(8.12)
N	10907	10907	10907	10907	10907	10907

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

7.5 Granger causality and dynamic panel data estimation

7.5.1 Methodology, data and variables

The second issue of this chapter is to test for Granger-causality links in the relationship between financial liberalisation, risk and efficiency. Building on the work of Berger and DeYoung (1997), Casu and Girardone (2009) and Fiordelisi et al. (2011), this chapter uses dynamic panel system GMM estimation with the empirical model following the autoregressive distribution lag (ARDL) linear equations:

$$Risk_{i,t} = f_1(Risk_{i,1ag}, CE_{i,lag}, PE_{i,lag}, FINLIB_{i,lag}, Z_{i,t}) + \varepsilon_{i,t} \quad (1)$$

$$CE_{i,t} = f_2(CE_{i,lag}, Risk_{i,1ag}, PE_{i,lag}, FINLIB_{i,lag}, Z_{i,t}) + \varepsilon_{i,t} \quad (2)$$

$$PE_{i,t} = f_3(PE_{i,lag}, Risk_{i,1ag}, CE_{i,lag}, FINLIB_{i,lag}, Z_{i,t}) + \varepsilon_{i,t} \quad (3)$$

$$FINLIB_{i,t} = f_1(FINLIB_{i,lag}, Risk_{i,1ag}, CE_{i,lag}, PE_{i,lag}, Z_{i,t}) + \varepsilon_{i,t} \quad (4)$$

where *i* donates the cross-sectional dimension (the banks), *t* denotes time, *Risk* represents the insolvency risk of banks (the Z-score), *CE* denotes cost efficiency score, *PE* denotes profit efficiency score, *FINLIB* denotes the *de jure* financial liberalisation measure, $Z_{i,t}$ represents a set of control variables and $\varepsilon_{i,t}$ is the random error term. The control variables ($Z_{i,t}$) include inflation (*INFA*), concentration (*CONC*) and the ratio of equity over assets (*EA*) to control for the macroeconomic environment, market structure, and bank-level differences in capital.

The first equation tests whether changes in efficiency temporally precede variations in banks' risk; while the second and third equations test whether changes in the risk temporally precede variations in efficiency (cost and profit). The fourth equation tests whether changes in risk temporally precede variations in financial is financial liberalisation index[29]. This chapter employs twos lag and estimate an AR (2) process for the variables of risk, efficiency and financial liberalisation as in Casu and Girardone (2009) and Fiordelisi et al. (2011). To test whether one variable Granger causes another is done by a joint test of the null hypothesis that the two lags of the causal variable is jointly

[29] The fourth equation implies bank-level variables (efficiency and risk) Granger-cause financial liberalisation. The logic of this implicit assumption is uncertain especially in the case of the de jure indicator of financial liberalisation. While acknowledging this shortcoming, this section mainly focuses on discussing the results of previous three equations.

equal to zero (Wald Test): $\beta_1 = \beta_2 = 0$, if the possibility is less than 10%, then reject the null hypothesis that *x* does not Granger-cause *y* at 10% significance level. The sum of these coefficients determines the sign of the causal relationship. On the other hand, since the dependent variable is a function of error term, the additional lagged dependent variable is correlated with the error term as well, making OLS estimator bias and inconsistent. This chapter uses the system generalized method of moments (GMM) estimators for dynamic panel data models as suggested by Arellano and Bover (1995) and Blundell and Bond (1998). Finally, Casu and Girardone (2009) and Fiordelisi et al. (2011) suggest using a test of the restriction of sum of lag coefficients equals to zero: $\beta_1 + \beta_2 = 0$ to measure the "long term effect" *x* on *y*, a rejection of the restriction implies *x* has long-term effect on *y*. This chapter uses the two-step GMM estimator with Windmeijer (2005) corrected standard error be reported in our analysis.

This chapter also reports the two tests: serial correlation and Sargan over identification test. Autocorrelation generally occurs when we use time series. Autocorrelation is a special case of correlation, and refers not to the relationship between two or more variables, but to the relationship between successive values of the same variable. One of the assumptions of regression analysis is that the error terms are independent from one another. The violation of this assumption gives rise to autocorrelation. If this assumption is not satisfied it means that the values of the error term are not independent, that is, the error in some period influences the error in some subsequent period or beyond. Arellano-Bond tests for autocorrelation AR1 and AR2 have a null hypothesis of no autocorrelation. Sargan test is a test of the validity of instrumental variables. It is a test of the over-identifying restriction. The hypothesis is being tested with the Sargan test is that the instrumental variable are uncorrelated to some set of residuals, and there for they are acceptable, healthy instruments. If the null hypothesis is confirmed statistically (that is not rejected) the instrument pass the test. They are valid by this criterion.

7.5.2 Empirical results

Table 7-8 to Table 7-11 show the results of the Granger causality relationships between risk, financial liberalisation and efficiency with a two-step SYS-GMM method

using two lags of the dependent and explanatory variables. Each table includes four columns: the first column has no control variables; the second column includes *INFA* (inflation) as the control variable; the third column adds *EA* (equity over assets); and the fourth column adds *CONC* (concentration). The year dummy variables and levels of economic development dummy variables are used as instrument variables in all specifications.

The first and second order serial correlation tests are reported by the AR (1) and AR (2) respectively. The first order serial correlation test AR (1) usually rejects the null hypothesis. The second order test AR (2) is more important because it will detect autocorrelation in levels. The over identification test of the GMM estimation is examined by the Sargan test which also support the instrument validity of the model. The Sargan test has a null hypothesis of "the instruments as a group are exogenous". Therefore, the higher the p-value of the Sargan test the better. The test statistics result does not mislead of the model.

Table 7-8 reports the empirical result of the Granger causality test when the dependent variable is risk (*Z-score*). The results show that cost efficiency (*CE*) positively Granger-causes the bank's risk due to the sum of lag coefficient being positive and statistically significant, while profit efficiency (*PE*) negatively Granger-causes the bank's risk. It implies that increasing the banks' cost efficiency (decreasing cost efficiency) Granger-causes lower (higher) probability of default risk. This result is consistent with the *bad management* hypothesis, in line with previous findings (Berger and DeYoung, 1997; Kwan and Eisenbeis, 1997; Williams, 2004; Fiordelisi et al., 2011). On the other hand, the results suggest that the increase (reduction) of banks' profit efficiency Granger-causes higher (lower) possibility of default risk. This result is supported by the *luck* hypothesis, which is the positive relationship between profit efficiency and risk due to the higher interest income of lower quality of loans (Fiordelisi et al., 2011), whereby increasing the possibility of insolvency risk. Concerning the effect of financial liberalisation, the results indicate that higher financial liberalisation temporally precedes higher possibility of default risk due to the negative sign of sum of lag coefficient and is significant in all specifications. The variable *INFA*, inflation, is negatively related to the risk and significant in specifications 2-4. The variable *EA*, ratio of equity over asset, in

columns 3 and 4 positively relates to risk. It implies that the higher leverage increases the possibility of insolvency risk of banks and is in line with the literature (Berger and Mester, 1997; Dietsch and Lozano-Vivas, 2000). The variable *CONC*, concentration, positively relates to the risk. It implies that the higher the concentration of the financial market, the less possibility of insolvency risk in the banking sector. One explanation might be the "too big to fail" scenario. Since the higher concentration, the less competition and monopoly power for major banks in the country, the big banks might intend to take excessive risk. Finally, regarding the long-run effect on the risk, evidence seems to suggest that profit efficiency has a long-run effect on banks' risk.

Table 7-9 reports the empirical results of the Granger causality test when the dependent variable is cost efficiency (*CE*). The results show that higher financial liberalisation Granger-causes higher cost efficiency. However, Z-score does not Granger-cause cost efficiency of banks due to the sum of lag coefficients being statistically insignificant in all specifications, so that one cannot reject the null hypothesis that risk does not Granger-cause efficiency.

Table 7-10 reports the empirical results of the Granger causality test when the dependent variable is profit efficiency (*PE*). The results show that risk, cost efficiency, and financial liberalisation do not Granger-cause the profit efficiency.

Table 7-11 reports the results when the dependent variable is financial liberalisation index (*FINLIB*), showing that risk, profit efficiency and cost efficiency do not Granger-cause financial liberalisation. Moreover, a low p-value (<0.10) for Sargan test statistics indicates that the model is probably misspecified. In this case, the Granger causality analysis cannot be satisfied.

Table 7-8 Effects of cost, profit efficiency and financial liberalisation on risk

Dependent Variable *y* = Z-score		(1)	(2)	(3)	(4)
$Z\text{-score}_{t-1}$		0.749***	0.757***	0.727***	0.735***
		(18.16)	(18.81)	(16.77)	(17.07)
$Z\text{-score}_{t-2}$		0.0747	0.0539	0.0679	0.0564
		(1.59)	(1.07)	(1.36)	(1.14)
CE_{t-1}		-1.560	-0.849	-0.862	-0.569
		(-1.44)	(-0.75)	(-0.74)	(-0.55)
CE_{t-2}		1.952***	2.126***	2.214***	1.924**
		(2.68)	(2.78)	(2.81)	(2.51)
∑ (CE)		0.392**	1.277***	1.352***	1.373**
H_0: $CE_{t-i}=0$	chi2(2)	7.29**	8.38**	9.29***	7.19**
	(Prob > chi2)	0.0262	0.0151	0.0096	0.0274
PE_{t-1}		-0.551*	-0.535	-0.418	-0.295
		(-1.79)	(-1.60)	(-1.27)	(-0.93)
PE_{t-2}		-0.756**	-0.784**	-0.756**	-0.760**
		(-2.19)	(-2.24)	(-2.20)	(-2.39)
∑ (PE)		-1.31***	-1.319***	-1.174***	-1.055***
H_0: $PE_{t-i}=0$	chi2(2)	12.92***	13.90***	10.74***	9.43***
	(Prob > chi2)	0.0016	0.0010	0.0047	0.0090
$FINLIB_{t-1}$		-0.248**	-0.250**	-0.252**	-0.210*
		(-2.09)	(-2.08)	(-2.13)	(-1.92)
$FINLIB_{t-2}$		0.199**	0.193***	0.186**	0.130*
		(2.56)	(2.66)	(2.57)	(1.78)
∑ (FINLIB)		-0.049**	-0.057**	-0.066***	-0.08*
H_0: $FINLIB_{t-i}=0$	chi2(2)	7.16**	7.64**	10.74***	4.65*
	(Prob > chi2)	0.0279	0.0220	0.0047	0.0979
INFA			-0.0105**	-0.0105**	-0.0106***
			(-2.51)	(-2.50)	(-2.65)
EA				0.770**	0.929***
				(2.45)	(2.90)
CONC					0.155*
					(1.66)
_cons		1.175*	1.716**	1.517**	1.530**
		(1.82)	(2.48)	(2.22)	(2.31)
N		10907	10907	10907	10907
AR(1),(p-value)		0.0000	0.0000	0.0000	0.0000
AR(2),(p-value)		0.6269	0.5517	0.4202	0.4245
Sargan test, (p-value)		0.2720	0.2734	0.2307	0.3089
H_0:$CE_1+CE_2 = 0$ (p-value)		0.6963	0.1974	0.1170	0.1337
H_0: $PE_1+PE_2 = 0$ (p-value)		0.0003	0.0002	0.0012	0.0032
H_0: $FINLIB_1+FINLIB_2 = 0$ (p-value)		0.6148	0.5762	0.5350	0.4152

Note: All models are estimated using the Arellano and Bond dynamic panel system GMM estimations. Windmeijer (2005) corrected standard error is reported in parentheses. Year dummies are included in all models. *, **, *** indicates significance at the 10%, 5% and 1% levels. Arellano-Bond tests for autocorrelation AR1 and AR2 have a null hypothesis of no autocorrelation. Sargan is a test of the over-identifying restrictions for the GMM estimators.

Table 7-9 Effects of risk, profit efficiency and financial liberalisation on cost efficiency

Dependent Variable y = CE		(1)	(2)	(3)	(4)
CE_{t-1}		0.560***	0.538***	0.536***	0.536***
		(7.56)	(6.92)	(6.89)	(6.86)
CE_{t-2}		0.0118	0.00135	0.00250	-0.00159
		(0.37)	(0.04)	(0.08)	(-0.05)
PE_{t-1}		0.0138	0.0323	0.0360	0.0414
		(0.35)	(0.83)	(0.93)	(1.06)
PE_{t-2}		-0.118***	-0.104***	-0.101***	-0.106***
		(-3.35)	(-2.92)	(-2.90)	(-3.07)
∑ (PE)		-0.1042***	-0.0717**	-0.065**	-0.0646***
H_0: PE_{t-i}=0	chi2(2)	13.37***	13.02**	8.65**	9.59***
	(Prob > chi2)	0.0012	0.0116	0.0132	0.0083
$FINLIB_{t-1}$		0.0327**	0.0291**	0.0293**	0.0321**
		(2.50)	(2.28)	(2.31)	(2.47)
$FINLIB_{t-2}$		-0.0151*	-0.0134	-0.0138	-0.0182*
		(-1.70)	(-1.49)	(-1.52)	(-1.82)
∑ (FINLIB)		0.0176*	0.0157**	0.0155*	0.0139**
H_0: $FINLIB_{t-i}$=0	chi2(2)	6.33**	5.24*	5.36*	6.24**
	(Prob > chi2)	0.0421	0.0729	0.0684	0.0443
$Z\text{-score}_{t-1}$		0.00639	0.00557	0.00507	0.00547
		(1.46)	(1.30)	(1.19)	(1.27)
$Z\text{-score}_{t-2}$		-0.00162	-0.00183	-0.00166	-0.00216
		(-0.31)	(-0.34)	(-0.31)	(-0.40)
∑ (Z-score)		0.0048	0.0037	0.0034	0.0033
H_0: $Z\text{-score}_{t-i}$=0	chi2(2)	2.14	1.71	1.42	1.63
	(Prob > chi2)	0.3428	0.4263	0.4927	0.4417
INFA			-0.00155***	-0.00155***	-0.00148***
			(-3.64)	(-3.68)	(-3.34)
EA				0.0324	0.0348
				(1.28)	(1.36)
CONC					0.0160
					(1.46)
_cons		0.394***	0.410***	0.405***	0.395***
		(4.90)	(4.91)	(4.87)	(4.82)
N		10907	10907	10907	10907
AR(1),(p-value)		0.0000	0.0000	0.0000	0.0000
AR(2),(p-value)		0.8215	0.6744	0.6712	0.6666
Sargan test, (p-value)		0.2013	0.2017	0.2066	0.3089
H_0:PE_1+PE_2 = 0 (p-value)		0.0057	0.0638	0.0865	0.0918
H_0: $FINLIB_1$+$FINLIB_2$ = 0 (p-value)		0.0953	0.1288	0.1292	0.1827
H_0: $Z\text{-score}_1$+$Z\text{-score}_2$ = 0 (p-value)		0.4330	0.5366	0.5723	0.5864

Note: All models are estimated using the Arellano and Bond dynamic panel system GMM estimations. Windmeijer (2005) corrected standard error is reported in parentheses. Year dummies are included in all models. *, **, *** indicates significance at the 10%, 5% and 1% levels. Arellano-Bond tests for autocorrelation AR1 and AR2 have a null hypothesis of no autocorrelation. Sargan is a test of the over-identifying restrictions for the GMM estimators.

Table 7-10 Effect of cost efficiency, risk and financial liberalisation on profit efficiency

Dependent Variable y = PE		(1)	(2)	(3)	(4)
PE_{t-1}		0.154	0.147	-0.00485	0.0464
		(0.52)	(0.47)	(-0.01)	(0.13)
PE_{t-2}		-0.224	-0.234	-0.374	-0.436
		(-1.02)	(-0.99)	(-1.27)	(-1.57)
CE_{t-1}		0.132**	0.0964	0.106	0.155
		(2.07)	(1.22)	(1.18)	(1.57)
CE_{t-2}		0.0153	0.0160	0.0546	0.0401
		(0.27)	(0.23)	(0.73)	(0.50)
∑ (CE)		0.1473	0.1124	0.1606	0.1951
H_0: CE_{t-i}=0	chi2(2)	4.46	1.77	2.38	3.29
	(Prob > chi2)	0.1077	0.4130	0.3036	0.1934
$FINLIB_{t-1}$		0.0703	0.0672	0.0695	0.0804
		(1.43)	(1.29)	(1.17)	(1.43)
$FINLIB_{t-2}$		-0.118**	-0.105*	-0.100	-0.139*
		(-2.11)	(-1.74)	(-1.42)	(-1.87)
∑ (FINLIB)		-0.0477	-0.0378	-0.0305	-0.0586
H_0: $FINLIB_{t-i}$=0	chi2(2)	4.49	3.03	2.02	3.53
	(Prob > chi2)	0.1058	0.2199	0.3648	0.1712
$Z\text{-score}_{t-1}$		-0.0446	-0.0311	-0.0340	-0.0285
		(-0.76)	(-0.49)	(-0.56)	(-0.44)
$Z\text{-score}_{t-2}$		0.0876	0.0866	0.0711	0.0519
		(1.47)	(1.36)	(1.00)	(0.61)
∑ (Z-score)		0.043	0.0555	0.0371	0.0234
H_0: $Z\text{-score}_{t-i}$=0	chi2(2)	2.36	2.02	1.00	0.37
	(Prob > chi2)	0.3076	0.3636	0.6064	0.8300
INFA			0.00248	0.00128	0.00324
			(0.44)	(0.21)	(0.47)
EA				-1.362	-1.488*
				(-1.51)	(-1.68)
CONC					0.101
					(0.75)
_cons		0.462**	0.446**	0.777**	0.755**
		(2.54)	(2.31)	(2.46)	(2.33)
N		10907	10907	10907	10907
AR(1),(p-value)		0.0071	0.0100	0.0140	0.0110
AR(2),(p-value)		0.3760	0.3720	0.2750	0.1410
Sargan test, (p-value)		0.0011	0.0000	0.0000	0.0000
H_0:CE_1+CE_2 = 0 (p-value)		0.0721	0.2218	0.1237	0.0791
H_0: $FINLIB_1$+$FINLIB_2$ = 0 (p-value)		0.2101	0.3572	0.4732	0.2753
H_0: $Z\text{-score}_1$+$Z\text{-score}_2$ = 0 (p-value)		0.3258	0.3227	0.5228	0.7129

Note: All models are estimated using the Arellano and Bond dynamic panel system GMM estimations. Windmeijer (2005) corrected standard error is reported in parentheses. Year dummies are included in all models. *, **, *** indicates significance at the 10%, 5% and 1% levels. Arellano-Bond tests for autocorrelation AR1 and AR2 have a null hypothesis of no autocorrelation. Sargan is a test of the over-identifying restrictions for the GMM estimators.

Table 7-11 Effects of cost, profit efficiency and risk on financial liberalisation

Dependent Variable y = FINLIB		(1)	(2)	(3)	(4)
$FINLIB_{t-1}$		0.944***	0.947***	0.947***	0.944***
		(26.39)	(25.06)	(24.99)	(25.81)
$FINLIB_{t-2}$		0.00886	0.00668	0.00734	0.0111
		(0.40)	(0.27)	(0.30)	(0.48)
CE_{t-1}		-0.0870	-0.0408	-0.0640	-0.0861
		(-0.35)	(-0.15)	(-0.24)	(-0.32)
CE_{t-2}		-0.131	-0.136	-0.143	-0.101
		(-0.72)	(-0.73)	(-0.75)	(-0.54)
∑ (CE)		-0.218	-0.1768	-0.207	-0.1871
H_0: CE_{t-i}=0	chi2(2)	0.88	0.72	0.85	0.61
	(Prob > chi2)	0.6445	0.6974	0.6525	0.7372
PE_{t-1}		0.0172	0.0269	0.0229	0.00685
		(0.30)	(0.47)	(0.40)	(0.12)
PE_{t-2}		-0.0458	-0.0517	-0.0540	-0.0606
		(-0.78)	(-0.87)	(-0.91)	(-1.05)
∑ (PE)		-0.0286	-0.0248	-0.0311	-0.05375
H_0: PE_{t-i}=0	chi2(2)	0.68	0.92	0.94	1.10
	(Prob > chi2)	0.7134	0.6293	0.6244	0.5783
$Z\text{-score}_{t-1}$		-0.0156	-0.0134	-0.0119	-0.0165
		(-0.66)	(-0.58)	(-0.52)	(-0.69)
$Z\text{-score}_{t-2}$		-0.0665*	-0.0604*	-0.0624*	-0.0526
		(-1.90)	(-1.72)	(-1.77)	(-1.46)
∑ (Z-score)		-0.0821**	-0.0738*	-0.0743*	-0.0691*
H_0: $Z\text{-score}_{t-i}$=0	chi2(2)	6.92**	5.82*	5.82*	5.30*
	(Prob > chi2)	0.0315	0.0544	0.0545	0.0708
INFA			0.00293	0.00286	0.00226
			(1.21)	(1.18)	(0.95)
EA				-0.129	-0.128
				(-1.07)	(-1.09)
CONC					-0.109*
					(-1.92)
_cons		0.554**	0.477*	0.521**	0.583**
		(2.37)	(1.94)	(2.06)	(2.36)
N		10907	10907	10907	10907
AR(1),(p-value)		0.0000	0.0000	0.0000	0.0000
AR(2),(p-value)		0.0488	0.0516	0.0545	0.0570
Sargan test, (p-value)		0.0000	0.0000	0.0000	0.0000
H_0:$CE_1+CE_2 = 0$ (p-value)		0.4003	0.5034	0.4411	0.4755
H_0: $PE_1+PE_2 = 0$ (p-value)		0.7165	0.7556	0.6952	0.4912
H_0: $Z\text{-score}_1+Z\text{-score}_2 = 0$ (p-value)		0.0086	0.0161	0.0159	0.0231

Note: All models are estimated using the Arellano and Bond dynamic panel system GMM estimations. Windmeijer (2005) corrected standard error is reported in parentheses. Year dummies are included in all models. *, **, *** indicates significance at the 10%, 5% and 1% levels. Arellano-Bond tests for autocorrelation AR1 and AR2 have a null hypothesis of no autocorrelation. Sargan is a test of the over-identifying restrictions for the GMM estimators.

7.6 Conclusion

This chapter has analysed the impact of financial liberalisation and risk on bank efficiency using the global frontier as well region specific frontiers, while controlling for the legal, political and economic institutional quality, financial regulation and supervision, and other country-level environmental factors. The analysis is based on the use of both stochastic frontier analysis (SFA) for cost and profit efficiency, and data envelopment analysis (DEA) for technical efficiency. Furthermore, the analysis is extended to investigate the inter-temporal relationships among bank efficiency (cost and profit), risk and financial liberalisation using Granger-causality and dynamic panel GMM estimation. The sample includes 10907 observations, 88 countries, and 1536 commercial banks of unbalanced panel data over the period from 2000 to 2009.

The results confirm that financial liberalisation has an independent effect on bank efficiency even in the presence of default risk and deposit insurance schemes, implying that higher level of financial liberalisation increases profit efficiency while decreases cost efficiency and technical efficiency, consistent with the results in Chapter 5 and 6. On the other hand, with regard to risk, the results support the "moral hazard" and "bad management" hypotheses that higher default risk decreases both cost and profit efficiency of banks. The link between lower cost efficiency and higher default risk is also confirmed by Granger causality analysis. The results also show that deposit insurance decreases efficiency while higher (country-level) degree of moral hazard increases efficiency, both cost and profit. Additionally, higher quality of legal institutions improves both cost and profit efficiency of banks while higher quality of political institutions enhances profit efficiency but impede cost efficiency of banks.

Additional results confirmed by Granger-causality investigating the links between financial liberalisation, risk and efficiency, the results show higher degree of financial liberalisation Granger causes higher possibility of default risk, implying that financial liberalisation leads to excessive risk-taking; meanwhile, the finding also suggests that higher financial liberalisation Granger causes higher cost efficiency. Moreover, the results suggest that higher profit efficiency Granger causes higher possibility of default risk and is in line with the "luck" hypothesis. However, the results show little evidence that risk Granger causes the other variables (cost or profit efficiency and degree of

financial liberalisation) and there are also limited evidence to show that financial liberalisation Granger causes profit efficiency of banks.

Appendix 7.A

Table 7.A Description of Institutional Quality Variables

Variable	Description	Source
Legal Institutional	Factor analysis by the following index by Kuncic (2012): (1) Index of Economic Freedom: Property rights; (2) Freedom of the Press: Legal Environment; (3) Freedom in the World: Civil Liberties: Rule of Law; (4) Freedom in the World: Civil Liberties; (5) EFW Index: Legal Structure and Security of Property Rights: Judicial independence; (6) EFW Index: Legal Structure and Security of Property Rights: Impartial courts; (7) EFW Index: Legal Structure and Security of Property Rights: Protection of property rights; (8) EFW Index: Legal Structure and Security of Property Rights: Military interference in rule of law and the political process; (9) EFW Index: Legal Structure and Security of Property Rights: Integrity of the legal system; (10) EFW Index: Legal Structure and Security of Property Rights: Legal enforcement of contracts; (11) Law and order; (12) Rule of Law.	Kuncic (2012)
Political Institutional	Factor analysis by the following index Kuncic (2012): (1) Freedom of the Press: Political Environment; (2) Freedom in the World: Political Rights: Electoral Process; (3) Freedom in the World: Political Rights: Political Pluralism and Participation; (4) Freedom in the World: Political Rights: Functioning of Government; (5) Freedom in the World: Political Rights; (6) Institutionalized Democracy - Institutionalized Autocracy; (7) Checks and balances; (8) Democratic accountability; (9) Corruption; (10) Bureaucratic quality; (11) Control of Corruption; (12) Corruption perceptions index; (13) Political terror scale.	Kuncic (2012)
Economic Institutional	Factor analysis by the following index Kuncic (2012): (1) Index of Economic Freedom: Financial Freedom; (2) Index of Economic Freedom: Freedom from Corruption; (3) Regulatory Quality; (4) Freedom of the Press: Economic Environment; (5) EFW Index: Regulation of Credit, Labour, and Business: Credit market regulations; (6) EFW Index: Regulation of Credit, Labour, and Business: Labour market regulations; (7) EFW Index: Regulation of Credit, Labour, and Business: Business Regulations; (8) Business freedom.	Kuncic (2012)
Deposit Insurance	Dummy that equals 1 if the country has explicit deposit insurance (including blanket guarantees) and 0 if it has implicit deposit insurance.	Barth et al. (2001, 2003, 2008)
Deposit Insurer Power	The variables is calculated by adding 1 is the answer is yes otherwise 0 is no: (1) to make the decision to intervene in a bank, (2) to take legal action against bank directors or officials, or (3) has ever taken any legal action against bank directors or	Barth et al. (2001, 2003, 2008)

	officers. The sum of the assigned values ranges from 0 to 3, with higher values indicating more power.	
Moral Hazard	Aggregate index of the variables: foreign deposits, interbank deposits, coinsurance, payment, premium, administration, and membership.	Barth et al. (2001, 2003, 2008)

CHAPTER 8

ACCOUNTING FOR THE ROLE OF COMPETITION AND RISK

8.1 Introduction

While allowing for the influence of deposit insurance and risk in analysing the impact of financial liberalisation on bank efficiency, the previous chapter showed that financial liberalisation contributes to higher default risk, while both have an impact on bank cost and profit efficiency. It is possible that financial liberalisation policies such as removing entry barriers and restrictions to capital flows will increase competition in the banking sector and erode banks' charter value, which in turn will induce banks to take on greater risk (Keeley, 1990). Therefore, market competition in the banking sector might be a possible mechanism through which financial liberalisation influences bank risk-taking and efficiency. However, in the empirical analysis so far, we have only used bank concentration (defined as the ratio of total assets of three largest commercial banks to the total assets of all commercial banks within a country) as a proxy for market power or competition. As Brissimis and Delis (2011) among others argue, a more appropriate measure of market power to measure the degree of competition in the market would be the Lerner or Boone index.

This chapter extends the analyses further to account explicitly for the influence of competition and risk in investigating whether financial liberalisation has an independent impact of bank efficiency, using both the Lerner and Boone indices as proxies to capture for the degree of competition in the market. As before, the one-step stochastic frontier analysis is used for the estimation of cost and profit efficiency, followed by the two-step data envelopment analysis for the estimation of technical efficiency. The analysis is supplemented by Granger causality analysis and GMM panel data estimation to identify the causal links between financial liberalisation, competition and default risk.

A large number of studies have analysed the relationship between competition and bank efficiency (Claessens and Laeven, 2004; Fernandez de Guevara et al., 2005; Schaeck and Cihak, 2008; Casu and Girardone, 2009), the relationship between competition and bank risk (Schaeck and Cihak, 2008; Turk Ariss, 2010), and the relationship between efficiency and risk (Berger and DeYoung, 1997; Girardone et al., 2004; Altunbas et al., 2007; Fiordelisi et al., 2011). A further strand of research investigates the quiet life hypothesis which posits a negative relationship between bank efficiency and market power and the efficient structure hypothesis which posits a positive relationship between bank efficiency and market power (Berger and Hannan 1998; Maudos and de Guevara, 2007; Koetter et al. 2012; Williams, 2012). Furthermore, a study by Delis (2012) investigates the impact of financial reforms on market competition while allowing for the influence of institutional factors, and finds that financial liberalisation contributes to reducing the market power of banks in developed countries with advanced institutions. However, there is no study linking the issue of financial liberalisation, competition and bank efficiency. This chapter therefore complements the analysis in Delis (2012) by investigating the impact of financial liberalisation on bank efficiency, while accounting for the influence of competition as a mechanism through which financial liberalisation could influence efficiency. Additionally, the analysis is also extended to account for the role of default risk, allowing the possibility to investigate causal links between financial liberalisation, competition and default risk

The chapter is organised as follows. Section 2 provides the theoretical background and discussion relating to competition and efficiency. Section 3 presents the empirical analysis for cost and profit efficiency while Section 4 does the same for technical efficiency. Section 5 conducts Granger causality analysis and section 6 concludes.

8.2 Theoretical background and discussion[30]

Financial liberalisation polices such as entry batter liberalisation and capital market liberalisation induce a surge in capital flows that is expected to increase with the intensity of competition in domestic markets though the entry new foreign banks and credit allocation. The intensity of competition may induce banks to take excessive risk which may improve their efficiency but this might also have implications for the stability of the banking system.

There is in fact a large body of theoretical and empirical literature which investigates the relationship between competition and stability. This is generally divided into three strands: "*competition-fragility*", "*competition-stability*" and "*competition-efficiency*" hypotheses. According to the "*competition-fragility*" view, competition erodes the charter value of banks which in turn, because of limited liability of banks, creates incentive for them to take excessive risk and threaten the stability of the banking system (Keeley, 1990). Hellmann et al. (2000) show that competition for deposits can also undermine prudent bank behaviour. They list the U.S. Savings and Loans crisis and the Japanese crisis as examples of excessive risk taking that led to large social costs. They put the blame on financial liberalization which removed barriers to entry and branching restrictions, in addition to deregulating interest rates. Increased competition for deposits, in turn, lowers bank profitability and destroys franchise value, fuelling moral hazard incentives. When banks are highly competitive and franchise values are low, banks have a moral hazard incentive to take risks because of the government safety net. That is, they have the option to "put" their assets to the deposit insurer or the government if they take risks and lose all their capital. The authors argue that deposit rate controls thwart the market-stealing effect and provide incentives for banks to behave prudently. They also argue that restrictions on competition for deposits are also more efficient than increasing capital requirements in curbing the "gambling for resurrection" behaviour. Furthermore, the intensive competitive environment makes banks gain less informational rents from borrowers, reducing their incentives to properly screen borrowers, which in turn increases the possibility of fragility (Allen and Gale, 2004).

[30] In addition to the theoretical background and discussion of this section, see also section 3.2.2 in Chapter 3 which discusses the evidence on competition and risk, and section 3.3.2 which discuss the evidence on competition and efficiency.

In contrast, the *competition-stability*" view emphasises that competition leads to greater stability of banks. Stiglitz and Weiss (1981) show that higher interest rates may increase the riskiness of loan portfolios because of adverse election (worse projects are funded) and moral hazard (risk shifting) problems. While increased funding costs discourage safer borrowers, other borrowers are induced to choose riskier project s and are likely to face a higher probability of default. The volume of nonperforming loans would then increase, adding to the bank's risk exposure and undermine financial stability. Boyd and De Nicolo (2005) explain that less competition means lower deposit rates and higher loan rates, which increases bank profits. In their view, the loan market dominates, thus increasing competition results in lower bank risk and more stability. Schaeck and Cihak (2008) further find that the intensity of competition increases bank soundness though the efficiency channel.

The "*competition-efficiency*" view is further divided into two strands. The "*quiet life*" hypothesis (Hicks, 1935) highlights that monopoly power gives managers opportunities for rent-seeking which create slack (or quiet life) through some form of discretionary expenditures. Hence, reducing market power or increasing competition would enhance cost efficiency. Leibenstein (1966) suggests that competition reduces the inefficiency through greater incentive of managers' efforts. On the other hand, the "*efficient structure*" hypothesis (Demsetz, 1973) suggests that cost efficiency reduces competition or increases market power as more efficient firms would have lower costs, higher profits and consequently larger market share (implying a reserve causal relationship between competition and efficiency). A large number of literatures investigate the relationship between competition and efficiency. Weill (2004) investigates the relationship between the competition (using Rosse-Panzar model H-statistic) and cost efficiency of the EU banking sector, and finds a negative relationship between competition and cost efficiency. Fernandez de Guevara et al. (2005) uses Lerner indicator as a proxy for market power of the EU banking sector and supports the negative relationship between competition and efficiency. Casu and Girardone (2009) employ Granger's causality GMM dynamic panel estimators method and find limited evidence to support increased that market power (Lerner indicator) translates to lower cost efficiency in main EU banks. Schaeck and Cihak (2008) find that competition improves bank

efficiency in EU and US banks. Delis and Tsionas (2009) employ a local maximum likelihood (LML) technique to drive bank-specific market power for US and EU banks, and find a negative relationship between market power and efficiency. Turk Ariss (2010) finds that a greater degree of market power enhances profit efficiency but that there is a significant loss of cost efficiency in developing countries. Williams (2012), in researching the market power and efficiency in Latin America banking, has discovered that the empirical results reject the "quiet life" hypothesis, while supporting the "efficient structure" hypothesis.

8.3 Cost and profit efficiency (SFA)

8.3.1 Empirical model, variables and data

This section employs the one-step stochastic frontier analysis based on the Battese and Coelli (1995) model with multiple outputs and inputs variables to estimate cost and profit efficiency of banks. As before, there are three outputs: loans (Q_1), other earning assets (Q_2), non-interest income (Q_3). Three inputs are: cost of loanable funds (W_1), estimated by the ratio of interest expense/ total deposits; cost of physical capital (W_2), measured by overhead expenses net of personnel expenses/book value of fixed assets; and cost of labour (W_3), defined as personnel expenses/total assets. Moreover, the equity is considered as quasi-fixed input (E) in the cost and profit function to control the different level of banks' risk profile.

Empirical estimation model

$$\ln\left(\frac{TC_{it}}{w_3}\right) = \beta_0 + \beta_1 \ln(Q1) + \beta_2 \ln(Q2) + \beta_3 \ln(Q3) + \beta_4 \ln\left(\frac{W_1}{W_3}\right) + \beta_5 \ln\left(\frac{W_2}{W_3}\right) + \beta_6 \frac{1}{2}\left(\ln(Q1)\right)^2$$
$$+ \beta_7 \ln(Q1)\ln(Q2) + \beta_8 \ln(Q1)\ln(Q3) + \beta_9 \frac{1}{2}\left(\ln(Q2)\right)^2 + \beta_{10} \ln(Q2)\ln(Q3)$$
$$+ \beta_{11} \frac{1}{2}\left(\ln(Q3)\right)^2 + \beta_{12} \frac{1}{2}\left(\ln\left(\frac{W_1}{W_3}\right)\right)^2 + \beta_{13} \ln(Q1)\left(\frac{W_1}{W_3}\right) + \beta_{14} \ln(Q2)\ln\left(\frac{W_1}{W_3}\right)$$
$$+ \beta_{15} \ln(Q3)\ln\left(\frac{W_1}{W_3}\right) + \beta_{16} \frac{1}{2}\left(\ln\left(\frac{W_2}{W_3}\right)\right)^2 + \beta_{17} \ln(Q1)\ln\left(\frac{W_2}{W_3}\right) + \beta_{18} \ln(Q2)\ln\left(\frac{W_2}{W_3}\right)$$
$$+ \beta_{19} \ln(Q3)\ln\left(\frac{W_2}{W_3}\right) + \beta_{20} \ln\left(\frac{W_1}{W_3}\right)\ln\left(\frac{W_2}{W_3}\right) + \beta_{21} T + \beta_{22} \frac{1}{2} T^2 + \beta_{23} T \ln(Q1)$$
$$+ \beta_{24} T \ln(Q2) + \beta_{25} T \ln(Q3) + \beta_{26} T \ln\left(\frac{W_1}{W_3}\right) + \beta_{27} T \ln\left(\frac{W_2}{W_3}\right) + \beta_{28} \ln(E) + \beta_{29} \frac{1}{2} \ln(E)^2$$
$$+ \beta_{30} \ln(E) \ln(Q1) + \beta_{31} \ln(E) \ln(Q2) + \beta_{32} \ln(E) \ln(Q3) + \beta_{33} \ln(E) \ln\left(\frac{W_1}{W_3}\right)$$
$$+ \beta_{34} \ln(E) \ln\left(\frac{W_2}{W_3}\right) + \beta_{35} D_{HIGH} + \beta_{36} D_{UPPH} + \beta_{37} D_{LOWMID} + v_{it} + u_{it}$$

Potential Determinant of inefficiency

In order to account for the impact of financial liberalisation and competition on the efficiency of banks, while at the same time controlling for intuitional quality and other country-specific variables, m_{it} is represented by:

$$m_{it} = \delta_0 + \delta_1 FINLIB + \delta_2 CAPR + \delta_3 SUP + \delta_4 PRIM + \delta_5 ACT + \delta_6 LERNER / BOONE$$
$$+ \delta_7 CLAIM + \delta_8 GDPGR + \delta_9 INFA + \delta_{10} HIGH + \delta_{11} UPPM + \delta_{12} LOWMID$$
$$+ \delta_{16} LEGAL + \delta_{17} POLIT + \delta_{19} Z - score$$

where *FINLIB, , SUP, PRIM, ACT, CLAIM, GDPGR, INFA, HIGH, UPPM, LOWMID, LEGAL* and *POLIT* are the same as in chapter 7; additionally, *LERNER* or *BOONE* index captures the degree of competition while *Z – score* refers to possibility of default risk (insolvency risk) of banks. The discussion below provides more specific details of the construction of the *LERNER / BOONE* index.

The Lerner Indicator of Monopoly Power

In this chapter, we use the Lerner indicator as our main measure of the degree of monopoly power. Consider a monopoly in which one firm is the only producer of a good. The demand for this good at price s given by the function *x(p)*, which we assume to be continuous and strictly decreasing at all p for which *x(p)* > 0. We assume that the monopolist knows the demand function for his product and can produce output level *y* at a cost of *c(y)*. The monopolist's decision problem consists of choosing the price *p* that maximizes his profits. Equivalently, the monopolist's optimization problem can be formulated in terms of the level of output he wants to sell, with the price at which he can sell his output given by the inverse demand function $p(y) = x^{-1}(y)$. The monopolist's maximization problem is max $p(y)y - c(y)$ subject y ≥ 0. Optimal monopoly output y^m satisfies $p(y^m) = c'(y^m) - p'(y^m)y^m$. For the typical case that p'(y) < 0 for all y ⩾ 0 , we have $p(y^m) > c'(y^m)$, so that the price under monopoly exceeds marginal costs (Koetter et al, 2012).

To measure the degree of monopoly power, Lerner (1934) considers the economic profit of the monopolist scaled by the price at the monopoly output level. Hence, the Lerner index of monopoly power is defined as:

$L = (p(y^m)-c'(y^m))/p(y^m)$

It is defined as the difference between price and marginal cost (MC), divided by price. Here, the marginal cost (MC) is calculated from a translog cost function with three inputs (labour, physical capital and deposits) and a single output (total assets) for each country separately to reflect different country-specific technologies

$$MC = \frac{Cost}{Q}\left[\beta_1 + \beta_2 \ln Q + \sum_{k=1}^{3} \phi \ln W_k + \delta_3 T\right]$$

The Lerner indicator is then computed as:

$$Lerner_{it} = (P_{it} - MC_{it}) / P_{it}$$

where P_{it} is the price of output, and Q and is calculated as the ratio of total revenue (interest income plus non-interest income) over total assets. In general, the index takes the value from 0 to 1 with LERNER=0 implying perfect competition, while LERNER=1 indicates monopoly.

The Boone Indicator of Market Power

An alternative way of measuring market power is the Boone indicator (Boone, 2001; Boone et al., 2005; Boone, 2008). The profit elasticity (Boone indicator) is an estimate of the percentage decrease in profits resulting from a 1 percent increase in the marginal cost:

$$profit\ elasticity_i = \frac{\partial \ln \pi_i}{\partial \ln mc_i} \ .$$

The basic idea behind the Boone indicator is that the more efficient bank has more profit with lower marginal cost than the less efficient bank. Such effects will be increased with a more competitive environment due to the decrease in entry costs or more aggressive interaction among banks, so that competition will be beneficial for the most efficient bank but harmful for the worst efficient bank. The implicit idea for this measure is that an increase in competition - due either to a decrease in entry costs or to goods becoming closer substitutes - will increase the profits of an efficient bank relative to the profits of a less efficient bank. In addition, the difference between profits will increase when the market is more competitive, as the more efficient market will penalize the least efficient bank more severely. In other words, the profit elasticity links bank performance with differences in efficiency (in terms of marginal cost). Schaeck and Cihak (2014) indicate that the Boone indicator has an appealing feature that it overcomes shortcomings of traditionally used proxies for competition, such as the three-bank concentration ratio, that gauge competition by examining concentration levels. Unlike concentration indices, the Boone indicator is able to capture interaction among banks by focusing on conduct, whereas concentration ratios only capture the outcomes of competitive conduct. Following Boone et al., (2005), the market power of firm is estimated by:

$$\ln \pi_i = \alpha + \beta \ln mc_i$$

where π is the profit of bank *i*, mc is the marginal cost, and β is the Boone indicator of market power. The larger β in absolute value implies the more competitive level of industry. For example, when β = - 0.5, a 1 % increase in the marginal cost of bank *i* will decrease its profits by 0.5 %. So that the more negative value of β refers to the more competition. Delis et al. (2010) has published a comprehensive dataset of market power

by using a partial linear smooth coefficient (PLSC) model, as a proxy of the Boone indicator at the country level. In this chapter, the dataset[31] of Delis et al. (2010) is used as proxy for the Boone indicator to reflect the degree of market power in the banking sector.

8.3.2 Empirical results

8.3.2.1 Cost and profit efficiency scores

Table 8-1 and Table 8-2 present the results of the cost and profit efficiency scores, respectively using the Lerner and Boone indices as proxies for market power, with results presented by year, geographical region, and income group level in Panels A, B and C separately. The results show that both profit and cost efficiency scores are little changed and therefore consistent with previous results.

[31] The dataset was kindly provided by Professor Manthos Delis of the University of Surrey.

Table 8-1 Cost and Profit efficiency estimation (Lerner)

	Number of observations	Cost efficiency		Profit efficiency	
		Mean	Std. Dev	Mean	Std. Dev
Panel A: mean by year					
2000	523	0.8823	0.0791	0.6231	0.1518
2001	632	0.8789	0.0806	0.6082	0.1525
2002	729	0.8741	0.0911	0.6203	0.1468
2003	833	0.8795	0.0932	0.6246	0.1488
2004	1008	0.8784	0.0896	0.6199	0.1514
2005	1177	0.8849	0.0835	0.6415	0.1299
2006	1240	0.8879	0.0775	0.6259	0.1376
2007	1204	0.8840	0.0849	0.5833	0.1641
2008	1097	0.8810	0.0811	0.5518	0.1848
2009	999	0.8908	0.0766	0.4407	0.2621
Panel B: mean by geographical region					
Asia Pacific	1903	0.8772	0.0919	0.6478	0.1573
Australasia	66	0.9031	0.0295	0.5208	0.1537
Eastern Europe	1087	0.8714	0.0608	0.5994	0.1903
Latin America	1642	0.8554	0.1069	0.5561	0.1779
Middle East and Africa	982	0.8930	0.0746	0.6647	0.1401
North America	89	0.8850	0.0569	0.5689	0.1393
Western Europe	3673	0.8981	0.0724	0.5585	0.1800
Panel C: mean by country group					
High income	4772	0.8918	0.0718	0.5699	0.1839
Upper middle income	412	0.9512	0.0206	0.6700	0.1319
Lower middle income	1751	0.8644	0.1006	0.6213	0.1612
Low income	2507	0.8673	0.0900	0.5997	0.1754
Overall mean	9442	0.8828	0.0814	0.5917	0.1775

Note: The means value by year, geographical region and income country group.

Table 8-2 Cost and Profit efficiency estimation (Boone)

	Number of observations	Cost efficiency		Profit efficiency	
		Mean	Std. Dev	Mean	Std. Dev
Panel A: mean by year					
2000	756	0.8753	0.0791	0.6026	0.1518
2001	816	0.8693	0.0806	0.5909	0.1525
2002	865	0.8679	0.0911	0.6046	0.1468
2003	954	0.8735	0.0932	0.6066	0.1488
2004	1121	0.8732	0.0896	0.6048	0.1514
2005	1284	0.8817	0.0835	0.6254	0.1299
2006	1340	0.8847	0.0775	0.6143	0.1376
2007	1317	0.8803	0.0849	0.5656	0.1641
2008	1248	0.8771	0.0811	0.5407	0.1848
2009	1206	0.8850	0.0766	0.4076	0.2621
Panel B: mean by geographical region					
Asia Pacific	2118	0.8728	0.0902	0.6239	0.1665
Australasia	68	0.8956	0.0360	0.5188	0.1547
Eastern Europe	1283	0.8671	0.0666	0.5832	0.1962
Latin America	1950	0.8559	0.1133	0.5388	0.1759
Middle East and Africa	1266	0.8743	0.0782	0.6296	0.1585
North America	128	0.8843	0.0535	0.5292	0.1560
Western Europe	4094	0.8944	0.0750	0.5458	0.1843
Panel C: mean by country group					
High income	5375	0.8881	0.0750	0.5557	0.1887
Upper middle income	504	0.8795	0.0756	0.6367	0.1466
Lower middle income	2106	0.8619	0.1030	0.5981	0.1663
Low income	2922	0.8695	0.0921	0.5775	0.1792
Overall mean	10907	0.8777	0.0864	0.5735	0.1815

Note: The means value by year, geographical region and income country group

8.3.2.2 Potential Correlates of Efficiency

Table 8-3 shows the empirical results highlighting the impact of financial liberalisation, competition (Lerner/Boone), default risk and other control variables on bank cost and profit inefficiency. In this chapter, the effect of financial liberalisation is represented by both the *de jure* index of *FINLIB*, as constructed by (Chinn and Ito 2008) to capture the intensity of capital market liberalisation, and the *de facto* measure representing the stock of foreign liabilities over GDP (Lane and Milesi-Ferretti, 2007; Kose et al., 2009). The results show that financial liberalisation continues to have a statistically significant and negative effect on the profit inefficiency of banks in all columns, implying that a higher level of financial liberalisation improves banks' profit efficiency (in line with the results of chapters 5 and 7). However, the impact of financial liberalisation on banks' cost efficiency is statistically significant but somewhat mixed. The *de jure* measure of financial liberalisation reduces cost efficiency (columns 1 and 3) irrespective of the measure of competition used, whereas the *de facto* measure of financial liberalisation negatively relates to cost inefficiency (column 7) when using the *Lerner indicator*, but positively relates to cost inefficiency when using the *Boone indicator* to control for market power.

Accounting for the influence of competition, the results show a significant and positive relationship between banks' degree of market power and cost inefficiency for both Lerner and Boone measures. This implies that the higher degree of banks' market power results in lower cost efficiency, providing support to the "*quiet life*" hypothesis which suggests that increased competition enhance cost efficiency; these results are in line with Delis and Tsionas (2009) and Turk Ariss (2010). On the other hand, the results show a statistically significant and negative relationship between bank's market power and profit inefficiency for both Lerner and Boone measures. This implies that the higher degree of banks' market power enhance profit efficiency of banks and are in line with Schaeck and Cihak (2008) and Turk Ariss (2010). Schaeck and Cihak (2008) indicate that banks with more market power are capable of gaining more revenue from diversified portfolios. Other results, including that of *Z-score*, are consistent with those of previous chapters.

8.3.3 Robustness analysis

For robustness, this section extends the analysis in three ways: (1) using separate frontiers for the four income group countries; (2) using the traditional intermediation approach (which excludes non-interest income); (3) adding the country-level risk factor (index of moral hazard) as the mean inefficiency term in the translog cost/profit function. All results are shown in Appendix 8.A. The results for the regional frontier analysis confirms that financial liberalisation has a statistically significant impact on cost and profit efficiency in both high and middle income countries, consistent with results in chapter 5 and 7. Other results on cost and profit efficiency are also very similar with those of the common global frontier and also consistent with the results in chapter 5 and 7. With regard to the impact of competition, most of the results are consistent with the common global frontier analysis in that that more competition enhances cost efficiency while less competition (high market power) enhances profit efficiency in all regions (high, upper-middle, middle-lower and lower income groups) using both *Lerner* and *Boone* measures.

Table 8-3 Determinants of cost and profit inefficiency

	CHIN (*de jure*) Financial Liberalisation				IMF (*de facto*) Financial Liberalisation			
	(1) Cost inefficiency	**(2)** Profit inefficiency	**(3)** Cost inefficiency	**(4)** Profit inefficiency	**(5)** Cost inefficiency	**(6)** Profit inefficiency	**(7)** Cost inefficiency	**(8)** Profit inefficiency
Constant	-15.5230***	-6.3651***	1.1878***	-4.2244***	-0.3275	-10.3100***	1.3981***	-5.3020***
	(3.8359)	(0.7882)	(0.0667)	(1.5953)	(0.2934)	(0.0059)	(0.2719)	(1.9417)
FINLIB	0.1195***	-0.0563***	0.0179***	-0.0234***	0.0089**	-0.1212***	-0.0344***	-0.0427***
	(0.0293)	(0.0034)	(0.0031)	(0.0085)	(0.0052)	(0.0323)	(0.0071)	(0.0155)
CAPR	-0.3866***	0.0789***	-0.0087***	0.0180***	-0.0205***	0.0191	-0.0123***	-0.0168***
	(0.0954)	(0.0067)	(0.0020)	(0.0070)	(0.0041)	(0.0347)	(0.0020)	(0.0060)
SUP	0.0845***	-0.0266***	-0.0017	-0.0156***	-0.0110***	-0.0428	-0.0071***	-0.0044***
	(0.0208)	(0.0011)	(0.0016)	(0.0044)	(0.0033)	(0.0585)	(0.0018)	(0.0016)
PRIM	0.2494***	0.1563***	0.0045	0.1050***	0.0091	0.4444***	0.0192***	0.2313***
	(0.0618)	(0.0211)	(0.0041)	(0.0382)	(0.0086)	(0.0387)	(0.0040)	(0.0847)
ACT	-0.8156***	0.1633***	0.0165***	0.1085***	-0.0058	0.2467***	0.0014	0.0129***
	(0.2014)	(0.0202)	(0.0065)	(0.0383)	(0.0134)	(0.0079)	(0.0065)	(0.0051)
LERNER/BOONE	1.9063***	-0.0688**	0.5735***	-2.2633***	0.0791***	-5.7852***	0.1589***	-1.2491***
	(0.4703)	(0.0378)	(0.0623)	(0.7638)	(0.0379)	(0.0098)	(0.0707)	(0.4659)
CLAIM	-0.2965***	-0.2808***	0.1564***	-0.1878***	0.0794***	-0.3012***	0.2328***	-0.3738***
	(0.0728)	(0.0605)	(0.0164)	(0.0699)	(0.0308)	(0.0037)	(0.0238)	(0.1383)
GDPGR	-0.0438***	-0.0654***	0.0019***	-0.0280***	0.0002	-0.1986***	0.0004***	-0.1128***
	(0.0107)	(0.0071)	(0.0009)	(0.0083)	(0.0018)	(0.0138)	(0.0012)	(0.0416)
INFA	0.0812***	0.0291***	0.0016***	0.0033**	-0.0014	0.0056	-0.0002	-0.0096***
	(0.0200)	(0.0044)	(0.0006)	(0.0019)	(0.0010)	(0.0140)	(0.0007)	(0.0034)
HIGH	0.1207***	0.4332***	-1.3120***	0.1252***	0.3841	2.0866***	-1.4179***	-0.0998***
	(0.0298)	(0.0257)	(0.0719)	(0.0615)	(0.2963)	(0.0069)	(0.2713)	(0.0426)
UPPH	0.1266***	0.5170***	-0.6222***	0.1224**	3.6409	2.8245***	1.6173***	0.2995***
	(0.0313)	(0.0459)	(0.0593)	(0.0672)	(10.2861)	(0.0100)	(0.7072)	(0.1058)
LOWMID	0.1357***	0.3962***	-0.8790***	0.0380	0.5758**	1.8429***	-0.5388**	-0.2647***
	(0.0335)	(0.0540)	(0.0463)	(0.0351)	(0.2968)	(0.0100)	(0.3057)	(0.0995)
LEGAL	0.0129***	-1.7208***	-0.0231	-1.3700***	-0.1971**	-3.4865***	-0.5137***	-0.9593***
	(0.0032)	(0.1405)	(0.0249)	(0.5184)	(0.1032)	(0.0080)	(0.0670)	(0.3368)
POLIT	-0.0296***	4.8173***	-0.1698***	2.4380***	-0.1326**	9.4046***	0.1829***	3.9575***
	(0.0073)	(0.6008)	(0.0361)	(0.9550)	(0.0746)	(0.0076)	(0.0458)	(1.4422)
Z-score	-0.8242***	-0.1356***	-0.0288***	-0.0893***	-0.0328***	-0.4693***	-0.0221***	-0.2677***
	(0.2041)	(0.0100)	(0.0036)	(0.0317)	(0.0079)	(0.0117)	(0.0036)	(0.0985)

Note: columns (1), (2), (5),(6) using Lerner indicator as a proxy of market power, columns (3),(4),(7),(8) using Boone indicator as a proxy of market power. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level.

8.4 Technical efficiency (DEA)

8.4.1 Empirical model, data and variables

As before, this chapter employs the two-stage Data Envelopment Analysis (DEA) for computation of technical efficiency. In the first stage, the efficiency scores (overall technical efficiency, pure technical efficiency and scale efficiency) are the same as obtained in Chapter 6 since all the input and output variables are the same.

The second step is now a regression model with efficiency score as the dependent variables and financial liberalisation, competition (market power), risk as the explanatory variables, along with the control variables (same as in chapter 7) so the model is specified as.

$$Y_{itc} = \alpha_0 + \alpha_1 FINLIB_{tc} + \alpha_2 COMPT_{tc} + \alpha_3 RISK_{itc} + \alpha_2 Z_{itc} + u$$

where Y is a vector of efficiency scores for country c at time t; *FINLIB* is the *de jure* measure of financial liberalisation for country c at time t; *COMPT* is the measure of the degree of market power as a proxy for competition (using both Lerner and Boone index); *RISK* is the measure of the default risk for bank i in country c at time t; Z is the vector of control variables which include both bank-specific variables and country-specific variables; and the random error term u. The regression is estimated by fixed effects regression from 2000 to 2009.

8.4.2 Empirical results

Table 8-4 and Table 8-5 report the results of second stage regression highlighting the impact of financial liberalisation and competition on bank overall technical efficiency, Table 8-4 showing the results using the Lerner index while Table 8-5 using the Boone index. In both Table 8-4 and Table 8-5, column [1] controls for bank-level specific variables only, column [2] adds financial regulation & supervision variables, column [3] adds market structure and macro-economic variables, column [4] adds institutional quality and risk and column [5] controls for all the variables simultaneously. All results confirm that financial liberalisation has a statistically significant and negative effect on bank technical efficiency, in line with the results of previous chapters. Concerning the degree of market power, the estimation results suggest a statistically significant and

negative relationship with overall technical efficiency. This implies that higher market power lowers overall technical efficiency, the result being robust using both the Lerner and Boone measures of market power; in other words, lower market power or higher competition enhances the overall technical efficiency of banks, consistent with the "*quiet life*" hypothesis.

Table 8-4 Financial liberalisation, competition and overall technical efficiency (Lerner)

	Bank Specific	Regulation & Supervision	Macro-economic Condition & Market structure	Institutional Quality & Risk	All control
	(1)	(2)	(3)	(4)	(5)
FINLIB	-0.0331***	-0.0338***	-0.0372***	-0.0337***	-0.0364***
	(-6.60)	(-6.66)	(-7.20)	(-6.57)	(-6.81)
LERNER	-0.0364***	-0.00756	-0.0546***	-0.115***	-0.0766***
	(-2.60)	(-0.51)	(-3.53)	(-6.87)	(-4.26)
EA	-0.0228	-0.0293	-0.0199	-0.0140	-0.0227
	(-0.72)	(-0.92)	(-0.65)	(-0.45)	(-0.72)
SIZE	-0.0278***	-0.0242***	-0.0224***	-0.0240***	-0.0186***
	(-6.85)	(-5.90)	(-5.44)	(-5.93)	(-4.49)
ROE	0.0534	0.0469	0.0589	0.0714	0.0616
	(1.34)	(1.24)	(1.43)	(1.53)	(1.41)
LD	0.00675**	0.00724***	0.00751***	0.00755***	0.00832***
	(2.44)	(2.58)	(2.64)	(2.64)	(2.84)
CAPR		0.000762			0.0000772
		(0.39)			(0.04)
SUP		0.00478***			0.00613***
		(3.07)			(3.94)
PRI		-0.00244			0.000147
		(-0.65)			(0.04)
ACT		-0.0587***			-0.0541***
		(-6.53)			(-6.23)
CLAIMS			-0.0358		-0.0693**
			(-1.41)		(-2.55)
INFLA			-0.00845***		-0.00374***
			(-11.38)		(-4.64)
GDPG			-0.00283***		-0.00193***
			(-5.64)		(-3.96)
Z-score				-0.0153*	-0.0175*
				(-1.69)	(-1.96)
LEGAL				-0.166***	-0.139***
				(-9.97)	(-7.22)
POLIC				-0.0382	0.0359
				(-0.78)	(0.72)
_cons	0.561***	0.631***	0.599***	0.715***	0.747***
	(19.82)	(16.93)	(22.14)	(16.62)	(16.37)
N	7181	7181	7181	7181	7181

Note: Estimated by fixed effects least square; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

Table 8-5 Financial liberalisation, competition and overall technical efficiency (Boone)

	Bank Specific	Regulation & Supervision	Macro-economic Condition & Market structure	Institutional Quality & Risk	All control
	(1)	(2)	(3)	(4)	(5)
FINLIB	-0.0307***	-0.0277***	-0.0323***	-0.0335***	-0.0296***
	(-7.81)	(-7.03)	(-7.97)	(-8.40)	(-7.17)
BOONE	-0.260***	-0.312***	-0.277***	-0.251***	-0.430***
	(-5.36)	(-6.52)	(-5.49)	(-5.16)	(-8.37)
EA	-0.0170	-0.0163	-0.0142	-0.0124	-0.0156
	(-0.62)	(-0.60)	(-0.53)	(-0.44)	(-0.56)
SIZE	-0.0224***	-0.0193***	-0.0163***	-0.0173***	-0.0109***
	(-6.51)	(-5.62)	(-4.75)	(-4.99)	(-3.17)
ROE	0.0414*	0.0404*	0.0382	0.0495*	0.0393
	(1.69)	(1.67)	(1.63)	(1.81)	(1.55)
LD	0.00433***	0.00419**	0.00436**	0.00435**	0.00425**
	(2.58)	(2.35)	(2.49)	(2.51)	(2.27)
CAPR		0.00200			0.00123
		(1.16)			(0.69)
SUP		0.00423***			0.00611***
		(3.15)			(4.42)
PRI		-0.00689**			-0.00717**
		(-2.11)			(-2.21)
ACT		-0.0678***			-0.0701***
		(-9.03)			(-9.51)
CLAIMS			-0.104***		-0.143***
			(-4.91)		(-6.06)
INFLA			-0.00723***		-0.00226***
			(-10.98)		(-3.35)
GDPG			-0.00334***		-0.00267***
			(-8.07)		(-6.82)
Z-score				-0.0192***	-0.0188***
				(-2.66)	(-2.67)
LEGAL				-0.116***	-0.141***
				(-8.68)	(-8.66)
POLIC				-0.190***	-0.0305
				(-4.43)	(-0.68)
_cons	0.392***	0.497***	0.450***	0.595***	0.635***
	(11.82)	(13.09)	(14.70)	(13.42)	(13.65)
N	8186	8186	8186	8186	8186

Note: Estimated by fixed effects least squares; Values in parenthesis are t-ratios based on White corrected heteroskedastic standard errors. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

8.5 Dynamic panel data estimation and Granger causality

8.5.1 Methodology, data and variables

The second issue of this chapter is to test for Granger-causality links between financial liberalisation, competition and risk. Building on the methodology of chapter 7, we use the dynamic panel GMM estimation, with the empirical model being the following set of autoregressive distribution lag (ARDL) linear equations:

$$COMPT_{i,t} = f_1(Risk_{i,1ag}, FINLIB_{i,lag}) + \varepsilon_{i,t} \qquad (1)$$

$$FINLIB_{i,t} = f_2(Risk_{i,1ag}, COMPT_{i,lag}) + \varepsilon_{i,t} \qquad (2)$$

$$Risk_{i,t} = f_1(FINLIB_{i,lag}, COMPT_{i,1ag}) + \varepsilon_{i,t} \qquad (3)$$

where i denotes the cross-sectional dimension (banks), t denotes time (year), *Risk* measures the default risk of banks using the Z-score, *FINLIB* denotes the *de jure* financial liberalisation index, *COMPT* denotes the degree of market power using both the Boone and Lerner indices.

8.5.2 Empirical results

Table 8-6, Table 8-7 and Table 8-8 present Granger causality results between financial liberalisation (*de jure*), competition (both Lerner and Boone indicators) and default risk using the SYS-GMM estimation with two lags for all the variables.

Table 8-6 reports the empirical results with the dependent variable being market power: Lerner in column (1) and Boone in column (2). The results show that the effect of financial liberalisation is statistically significant and negative with Bonne indicator due to the sum of coefficient being negative. This implies that financial liberalisation reduces market power, as measured by the Boone indicator. This result is consistent with Delis (2012). However, on the Lerner measure (column 1) we fail to find a statistically significant relationship between financial liberalisation and bank level competition due to the sum of lagged coefficients being statistically insignificant. On the other hand, the results show the bank-level risk, proxied by *Z-score*, has a statistically significant and negative impact on market power for both Lerner and Boone indicators, suggesting that higher possibility of banks' default risk leads to greater degree of market power, at both bank level and country level, implying higher concentration in the banking markets.

Table 8-7[32] presents the empirical results with the dependent variable being financial liberalisation. The results show that sum of the coefficients of the (lagged) Lerner indicator is statistically significant and positive on financial liberalisation. This implies that increased market power temporally precedes financial liberalisation. However, concerning the country-level market power, proxied by the Boone indicator, the results show that decreased market power precedes financial liberalisation. Hence, the results are inconclusive regarding the relationship between competition and financial liberalisation. The results may explain by the authorities normally clean up troubled financial institutions and try to engineer an increase in the overall competitiveness of the financial sector prior to liberalising the banking sector. Altunbaş and Marqués (2008) indicate that financial liberalisation increases mergers and acquisitions (M&A) activity, changes the market competition position. Furthermore, the results show that Z-score has a statistically significant and negative effect on financial liberalisation, implying that higher possibility of default risk can impede the process of financial liberalisation.

Finally, Table 8-8 reports the results when the dependent variable is Z-score. We fail to find any statistically significant causality running from financial liberalisation and Lerner indicator to Z-score. On the other hand, results in column (2) show that increases in financial liberalisation and country-level market power precedes the lower Z-score, implying that financial liberalisation as well as increased market power Granger cause greater possibility of default risk.

[32] The second equation implies the competition and risk Granger-cause financial liberalisation. The logic of this implicit assumption is uncertain especially in the case of the de jure indicator of financial liberalisation. While acknowledging this shortcoming, this section mainly focuses on discussing the results of the first and the third equations.

Table 8-6 Effects of Financial liberalisation, risk on market power

Dependent Variable		**(1)**	**(2)**
***y* = Competition**		**LERNER**	**BOONE**
$LERNER_{t-1}/BOONE_{t-1}$		4.243**	0.463***
		(2.20)	(3.34)
$LERNER_{t-2}/BOONE_{t-2}$		-2.737	-0.240*
		(-1.36)	(-1.83)
$FINLIB_{t-1}$		0.213	0.313***
		(0.87)	(6.06)
$FINLIB_{t-2}$		-0.210	-0.324***
		(-0.83)	(-5.93)
∑ (FINLIB)		0.003	-0.011***
H_0: $FINLIB_{t-i}$=0	chi2(2)	0.98	6.37
	(Prob > chi2)	0.6137	0.0415
$Z\text{-score}_{t-1}$		-0.282	0.185***
		(-1.58)	(2.78)
$Z\text{-score}_{t-2}$		0.269**	-0.216***
		(2.13)	(-2.79)
∑ (Z-score)		-0.013***	-0.031***
H_0: $Z\text{-score}_{t-i}$=0	chi2(2)	45.56	7.77
	(Prob > chi2)	0.0000	0.0205
_cons		-0.219*	-0.257***
		(-1.81)	(-4.78)
N		5750	6943
AR(1),(p-value)		0.090	0.000
AR(2),(p-value)		0.147	0.244
Sargan test, (p-value)		0.227	0.917
H_0: $FINLIB_1$+$FINLIB_2$ = 0 (p-value)		0.9896	0.0037
H_0: $Z\text{-score}_1$+$Z\text{-score}_2$ = 0 (p-value)		0.8660	0.0070

Note: All models are estimated using the Arellano and Bond dynamic panel system GMM estimations. Windmeijer (2005) corrected standard error is reported in parentheses. Year dummies are included in all models. *, **, *** indicates significance at the 10%, 5% and 1% levels. Arellano-Bond tests for autocorrelation AR1 and AR2 have a null hypothesis of no autocorrelation. Sargan is a test of the over-identifying restrictions for the GMM estimators.

Table 8-7 Effects of competition, risk on financial liberalisation

Dependent Variable		**(1)**	**(1)**
***y* = Financial liberalisation**		**LERNER**	**BOONE**
$FINLIB_{t-1}$		-0.275	-1.585***
		(-0.65)	(-5.09)
$FINLIB_{t-2}$		0.529*	1.142***
		(1.74)	(3.82)
$LERNER_{t-1}/BOONE_{t-1}$		0.992***	-7.709**
		(2.90)	(-2.39)
$LERNER_{t-2}/BOONE_{t-2}$		-0.661	6.604**
		(-1.61)	(2.34)
∑ (LERNER/BOONE)		0.331***	-1.105**
H_0: LERNER/BOONE $_{t-i}$=0	chi2(2)	10.66	5.76
	(Prob > chi2)	0.0048	0.0562
$Z\text{-score}_{t-1}$		-1.357**	0.0943*
		(-2.09)	(1.88)
$Z\text{-score}_{t-2}$		1.870**	0.208***
		(2.09)	(2.62)
∑ (Z-score)		0.5129**	0.3023***
H_0: $Z\text{-score}_{t-i}$=0	chi2(2)	4.97	8.59
	(Prob > chi2)	0.0832	0.0034
_cons		-0.728	0.427
		(-0.39)	(0.87)
N		5750	6943
AR(1),(p-value)		0.068	0.044
AR(2),(p-value)		0.51	0.399
Sargan test, (p-value)		0.733	0.17
H_0: $LERNER_1/BOONE_1$+ $LERNER_2/BOONE_2$= 0 (p-value)		0.1385	0.2922
H_0: $Z\text{-score}_1$+$Z\text{-score}_2$ = 0 (p-value)		0.3851	0.0136

Note: All models are estimated using the Arellano and Bond dynamic panel system GMM estimations. Windmeijer (2005) corrected standard error is reported in parentheses. Year dummies are included in all models. *, **, *** indicates significance at the 10%, 5% and 1% levels. Arellano-Bond tests for autocorrelation AR1 and AR2 have a null hypothesis of no autocorrelation. Sargan is a test of the over-identifying restrictions for the GMM estimators.

Table 8-8 Effects of competition, financial liberalisation on risk

		(1)	(1)
***y* = Z - score**		**LERNER**	**BOONE**
Z-score$_{t-1}$		-0.953	0.612***
		(-0.80)	(2.75)
Z-score$_{t-2}$		1.306	0.413
		(1.49)	(1.59)
LERNER$_{t-1}$/BOONE$_{t-1}$		5.652	-4.681***
		(1.64)	(-3.79)
LERNER$_{t-2}$/BOONE$_{t-2}$		-5.129	3.891***
		(-1.63)	(3.01)
∑ (LERNER/BOONE)		0.523	-0.79***
H$_0$: LERNER/BOONE $_{t-i}$=0	chi2(2)	2.74	16.11
	(Prob > chi2)	0.2545	0.0003
FINLIB$_{t-1}$		0.0492	-0.155
		(0.51)	(-0.92)
FINLIB$_{t-2}$		-0.00575	-0.447**
		(-0.13)	(-2.40)
∑ (FINLIB)		0.04345	-0.602***
H$_0$: FINLIB$_{t-i}$=0	chi2(2)	0.27	10.45
	(Prob > chi2)	0.8722	0.0054
_cons		1.498	0.254
		(0.58)	(0.84)
N		5750	6943
AR(1),(p-value)		0.043	0.091
AR(2),(p-value)		0.587	0.462
Sargan test, (p-value)		0.951	0.135
H$_0$: LERNER$_1$/BOONE$_1$+ LERNER$_2$/BOONE$_2$= 0 (p-value)		0.1398	0.1062
H$_0$: FINLIB$_1$+FINLIB$_2$ = 0 (p-value)		0.6149	0.0015

Note: All models are estimated using the Arellano and Bond dynamic panel system GMM estimations. Windmeijer (2005) corrected standard error is reported in parentheses. Year dummies are included in all models. *, **, *** indicates significance at the 10%, 5% and 1% levels. Arellano-Bond tests for autocorrelation AR1 and AR2 have a null hypothesis of no autocorrelation. Sargan is a test of the over-identifying restrictions for the GMM estimators.

8.6 Conclusion

This chapter has extended the analysis of previous chapters to investigate two main issues: first, whether financial liberalisation has as independent effects on bank efficiency when controlling the degree of competition or market power; second, how the latter also influences bank efficiency. In order to address these issues, the Battese and Coelli (1995) model is used for the estimation of cost and profit efficiency, allowing for the estimation of a global frontier while simultaneously incorporating various country-specific controls with robustness analysis conducted across region specific (income group) frontiers, two measures of financial liberalisation, traditional intermediation approach and including country level risk in the mean inefficiency terms. Additionally, the two-stage DEA approach is used for the computation of technical efficiency. Finally, dynamic panel data estimation is employed using SYS-GMM methods to investigate Granger causality relationships between financial liberalisation, competition and risk.

The results of this chapter confirm the earlier findings that financial liberalisation exerts an independent effect on banks' cost, profit and technical efficiency. Additionally, accounting for the influence of competition using both the Lerner and Boone measures, the results suggest that higher degree of market power reduces the cost efficiency of banks, in line with the "*quiet life*" hypothesis, while increasing the profit efficiency. Conversely, therefore, more competition enhances cost efficiency but undermines profit efficiency. This finding is robust across numerous specifications. Further, the results of Granger-causality analysis confirm that financial liberalisation contributes to greater competition in the market (by decreasing market power at country-level as measured by the Boone indicator), while greater competition temporally precedes financial liberalisation. In other words, according to the Boone index, we find Granger-causality links between financial liberalisation and competition in both directions. However, using the bank level Lerner index, we fail to find any Granger causality link between financial liberalisation and competition.

Appendix 8.A

Table 8. A.1 Potential determinants on cost and profit inefficiencies (Regional frontier)

Panel A: Cost Inefficiencies					**Panel B: Alternative Profit Inefficiency**			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	-2.5926***	-6.0380***	-1.0987***	0.2504	-21.6240***	-4.7537***	-16.7856***	-1.4655
	(0.8309)	(0.0099)	(0.4843)	(0.4028)	(2.7469)	(0.0179)	(4.5698)	(2.9898)
FINLIB	1.0021***	-0.0779***	0.0788***	0.0383	-2.9656***	-0.0979***	1.4912***	1.0184
	(0.3094)	(0.0100)	(0.0153)	(0.0426)	(0.3633)	(0.0326)	(0.3645)	(0.7573)
CAPR	0.0695***	-0.3819***	-0.0959***	-0.0609***	0.5920***	0.1184***	0.5437***	-0.0023
	(0.0213)	(0.0080)	(0.0472)	(0.0270)	(0.0708)	(0.0265)	(0.1978)	(0.0987)
SUP	-0.1401***	0.1673***	-0.0577**	-0.0314***	-0.5173***	0.0006	0.8877***	-0.5266
	(0.0435)	(0.0183)	(0.0307)	(0.0147)	(0.0671)	(0.0157)	(0.2185)	(0.4491)
PRIM	1.0203***	0.1942***	-0.0453***	0.1165***	0.1485***	0.1345***	-0.2965	0.8585
	(0.3176)	(0.0062)	(0.0223)	(0.0434)	(0.0190)	(0.0395)	(0.2210)	(0.8518)
ACT	-3.6770***	0.0506***	0.1484***	-0.2122***	0.1184***	0.2564***	-1.9488***	0.9737
	(1.1387)	(0.0081)	(0.0456)	(0.0802)	(0.0103)	(0.0570)	(0.5274)	(0.8360)
LERNER	0.1698***	2.5639***	0.1496***	0.2312***	3.6756***	-0.5700***	1.0157	-2.5513
	(0.0568)	(0.0097)	(0.0760)	(0.0773)	(0.4355)	(0.0407)	(0.8862)	(1.8644)
CLAIM	-3.7162***	0.8434***	0.8648***	-1.7635***	1.2218***	-0.8747***	9.1110***	1.1274
	(1.1494)	(0.0096)	(0.1813)	(0.5900)	(0.1631)	(0.0976)	(2.0225)	(2.7064)
GDPGR	0.0753***	0.0518***	-0.2182	-0.0091	-0.9926***	-0.0384***	-0.1984***	0.0207
	(0.0234)	(0.0137)	(0.3249)	(0.0059)	(0.1174)	(0.0115)	(0.0703)	(0.0782)
INFA	0.3968***	0.0399	0.0152	0.0067	0.5862***	-0.0049	0.0525	0.0772
	(0.1230)	(0.0298)	(0.0155)	(0.0044)	(0.0791)	(0.0082)	(0.0480)	(0.0606)
LEGAL	-1.5730***	-0.2499***	-0.0144	-0.2733***	-5.7198***	-1.1690***	-6.8135***	-3.1270
	(0.4900)	(0.0100)	(0.0095)	(0.1113)	(0.8180)	(0.1260)	(1.5521)	(2.1203)
POLIC	0.6858***	-3.8300***	2.2412***	1.6111***	16.8790***	3.7512***	17.6442***	-1.4169
	(0.2164)	(0.0100)	(0.3038)	(0.4388)	(2.2154)	(0.0150)	(4.1472)	(3.1860)
Z-score	-1.4365***	-0.2377***	-2.4216***	-0.0348***	-0.5916***	-0.0329	-1.0574***	-0.1322
	(0.4424)	(0.0085)	(0.3278)	(0.0160)	(0.0705)	(0.0294)	(0.2539)	(0.1052)

Note: column (1) refers to the high income economics; column (2) refers to the upper-middle income economies; column (3) refers to the middle-lower income economies; column (4) refers to the lower income economies. Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level.

Table 8.A.2 Potential determinants on cost and profit inefficiencies (Regional frontier)

Panel A: Cost Inefficiencies					**Panel B: Alternative Profit Inefficiency**			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	2.5353***	-2.8740***	-1.5325	2.5353***	-3.0266***	-2.5716***	-22.5790***	9.6234
	(0.8463)	(1.1814)	(1.5131)	(0.8463)	(1.0293)	(1.0909)	(5.7259)	(21.2602)
FINLIB	-0.0050	0.0022***	0.5988***	-0.0050	-0.1435***	-0.0061	1.6080***	2.8105
	(0.0714)	(0.0008)	(0.1215)	(0.0714)	(0.0397)	(0.0093)	(0.4356)	(2.5518)
CAPR	-0.0521**	-0.0841***	-0.0889	-0.0521**	0.0135***	0.0406***	0.5387***	-2.3118
	(0.0293)	(0.0345)	(0.0850)	(0.0293)	(0.0050)	(0.0190)	(0.1878)	(1.5607)
SUP	-0.0551***	0.1226***	0.0493	-0.0551***	-0.0535***	-0.0022	0.9753***	-0.3264
	(0.0267)	(0.0504)	(0.0618)	(0.0267)	(0.0162)	(0.0034)	(0.2614)	(0.6957)
PRIM	0.2013***	0.0778***	0.7089***	0.2013***	0.0834***	0.0875***	-0.1172	2.5301
	(0.0463)	(0.0320)	(0.1416)	(0.0463)	(0.0291)	(0.0380)	(0.1292)	(1.7906)
ACT	-0.2537**	0.1535***	-1.2243***	-0.2537**	0.0430***	0.1511***	-2.1988***	4.2458
	(0.1338)	(0.0632)	(0.2235)	(0.1338)	(0.0134)	(0.0655)	(0.6868)	(3.2924)
BOONE	4.3234***	0.0139**	-1.9368	4.3234***	-1.9291***	-1.8616***	-7.2512***	62.5182
	(1.9501)	(0.0076)	(1.5804)	(1.9501)	(0.6488)	(0.7409)	(1.6235)	(64.8972)
CLAIM	-3.9986***	0.5825***	-0.0413	-3.9986***	-0.0065	-0.3324***	9.4234***	-42.6593
	(0.8159)	(0.2402)	(0.8947)	(0.8159)	(0.0055)	(0.1558)	(2.3095)	(31.5814)
GDPGR	-0.0089	-0.0003***	0.0166	-0.0089	-0.0559***	-0.0138***	-0.1244***	0.0829
	(0.0064)	(0.0001)	(0.0278)	(0.0064)	(0.0161)	(0.0056)	(0.0441)	(0.1946)
INFA	0.0035	0.0165***	-0.1158***	0.0035	0.0358***	-0.0086***	-0.0046	0.2586**
	(0.0050)	(0.0068)	(0.0288)	(0.0050)	(0.0130)	(0.0040)	(0.0283)	(0.1500)
LEGAL	-0.1436	0.0120***	1.4156	-0.1436	-1.1241***	-0.7196***	-9.6584***	-12.1496***
	(0.1928)	(0.0042)	(0.9827)	(0.1928)	(0.3687)	(0.3010)	(2.4542)	(5.4170)
POLIC	1.2136***	-0.7366***	-3.7142***	1.2136***	1.7920***	0.7370***	18.7000***	22.8557
	(0.4515)	(0.3043)	(0.9962)	(0.4515)	(0.5839)	(0.3555)	(4.6981)	(14.8977)
Z-score	-0.0912***	-0.0447***	-0.6374***	-0.0912***	-0.0607***	-0.0398***	-0.8377***	-1.4425***
	(0.0230)	(0.0184)	(0.1017)	(0.0230)	(0.0173)	(0.0134)	(0.2645)	(0.5262)

Note: column (1) refers to the high income economics; column (2) refers to the upper-middle income economies; column (3) refers to the middle-lower income economies; column (4) refers to the lower income economies. Standard error is reported in parentheses. ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level.

Table 8. A. 3 Determinants of cost and profit inefficiency (Traditional intermediation approach)

	LERNER Indicator		BOONE Indicator	
	Cost inefficiency	Profit inefficiency	Cost inefficiency	Profit inefficiency
Constant	-1.6942***	-5.2195***	-2.8217***	-3.8433***
	(0.3853)	(0.9353)	(0.9628)	(0.7347)
FINLIB	0.0442***	-0.0516***	0.0593***	-0.0273***
	(0.0100)	(0.0063)	(0.0204)	(0.0045)
CAPR	-0.0705***	0.0621***	-0.0876***	0.0158***
	(0.0160)	(0.0124)	(0.0299)	(0.0028)
SUP	0.0068***	-0.0148***	0.0197***	-0.0125***
	(0.0016)	(0.0023)	(0.0067)	(0.0018)
PRIM	0.0216***	0.1188***	0.0514***	0.0948***
	(0.0049)	(0.0294)	(0.0175)	(0.0176)
ACT	-0.1821***	0.1095***	-0.2513***	0.0897***
	(0.0413)	(0.0244)	(0.0857)	(0.0139)
LERNER/BOONE	0.4366***	-0.0386***	-2.7688***	-1.9915***
	(0.0992)	(0.0698)	(0.9471)	(0.4061)
CLAIM	-0.1188***	-0.2223***	-0.3397***	-0.1637***
	(0.0268)	(0.0599)	(0.1159)	(0.0423)
GDPGR	-0.0203***	-0.0546***	-0.0187***	-0.0276***
	(0.0046)	(0.0085)	(0.0063)	(0.0040)
INFA	0.0116***	0.0235***	0.0111***	0.0031***
	(0.0026)	(0.0044)	(0.0038)	(0.0006)
HIGH	1.3020***	0.3390***	1.1168***	0.0849***
	(0.2953)	(0.0699)	(0.3797)	(0.0422)
UPPH	1.1496***	0.4253***	0.6075***	0.0959***
	(0.2607)	(0.0744)	(0.2063)	(0.0302)
LOWMID	1.4860***	0.3780***	1.0853***	0.0436**
	(0.3370)	(0.0664)	(0.3694)	(0.0234)
LEGAL	0.0299***	-1.4182***	-0.4297***	-1.2633***
	(0.0069)	(0.2670)	(0.1465)	(0.2429)
POLIT	-0.4815***	4.0381***	-0.5092***	2.2834***
	(0.1089)	(0.7031)	(0.1736)	(0.4639)
Z-score	-0.1863***	-0.1100***	-0.2526***	-0.0745***
	(0.0423)	(0.0135)	(0.0862)	(0.0133)

Note: ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level. Standard error is reported in parentheses.

Table 8. A. 4 Determinants of cost and profit inefficiency (adding country-level risk)

	LERNER Indicator		BOONE Indicator	
	Cost inefficiency	Profit inefficiency	Cost inefficiency	Profit inefficiency
Constant	-5.7440***	-1.6364***	-3.7906***	-3.8602***
	(1.4826)	(0.3202)	(1.0410)	(1.0914)
FINLIB	-0.2352***	-0.0150***	-0.1530***	-0.0170***
	(0.0607)	(0.0026)	(0.0420)	(0.0064)
CAPR	0.0600***	0.0201***	0.0496***	0.0193***
	(0.0155)	(0.0032)	(0.0136)	(0.0054)
SUP	0.0471***	-0.0060***	0.0150***	-0.0126***
	(0.0121)	(0.0003)	(0.0041)	(0.0022)
PRIM	-0.0342***	0.0399***	-0.0371***	0.0910***
	(0.0088)	(0.0078)	(0.0101)	(0.0239)
ACT	-0.0229***	0.0421***	-0.0691***	0.0993***
	(0.0060)	(0.0088)	(0.0190)	(0.0268)
LERNER/BOONE	0.4115***	-0.0127**	-2.6682***	-2.0926***
	(0.1059)	(0.0071)	(0.7318)	(0.5700)
CLAIM	-0.1583***	-0.0767***	-0.2786***	-0.1874***
	(0.0408)	(0.0223)	(0.0764)	(0.0539)
GDPGR	-0.0173***	-0.0169***	-0.0137***	-0.0264***
	(0.0045)	(0.0032)	(0.0038)	(0.0062)
INFA	-0.0055***	0.0077***	-0.0112***	0.0023***
	(0.0014)	(0.0015)	(0.0031)	(0.0010)
HIGH	1.8805***	0.1070***	-0.2016***	0.1229***
	(0.4866)	(0.0140)	(0.0551)	(0.0509)
UPPH	2.7398***	0.1257***	0.5312***	0.1120***
	(0.7080)	(0.0197)	(0.1457)	(0.0433)
LOWMID	1.3091***	0.0927***	-0.9271***	0.0466
	(0.3390)	(0.0178)	(0.2546)	(0.0333)
LEGAL	0.2230***	-0.4352***	-0.0533***	-1.2589***
	(0.0574)	(0.0702)	(0.0145)	(0.3575)
POLIT	2.4584***	1.2493***	1.7134***	2.2734***
	(0.6334)	(0.2531)	(0.4696)	(0.6702)
Z-score	-0.0257***	-0.0340***	0.0281***	-0.0836***
	(0.0066)	(0.0053)	(0.0077)	(0.0233)
MORAL	0.0315***	-0.0014***	0.0398***	-0.0150***
	(0.0081)	(0.0003)	(0.0109)	(0.0048)

Note: ***statistical significance at the 1% level, **statistical significance at the 5% level, *statistical significance at the 10% level. Standard error is reported in parentheses,

CHAPTER 9
CONCLUSION

9.1 Introduction

This study has examined the impact of financial liberalisation on the banking sector. It draws on the established literature relating financial liberalisation to economic growth and financial fragility (or banking crises), and identifies a comprehensive set of measures and data covering different dimensions of financial liberalisation which are then applied in the empirical analysis to determine the impact of financial liberalisation on bank performance, as measured in terms of bank efficiency and productivity.

In contrast to a large literature that exists on financial liberalisation and economic growth, there is comparatively limited research, particularly at the international level, investigating the impact of financial liberalisation on banking sector performance. The purpose of the study is thus to provide international evidence relating to the impact of financial liberalisation by focussing more narrowly on the banking sector. A parametric stochastic frontier analysis (SFA) is used to estimate the cost and profit efficiency of banks while the non-parametric data envelopment analysis (DEA) is used to estimate the technical efficiency of banks. The latter is complemented by DEA-type Malmquist index to also estimate the total factor productivity (TFP) growth of banks. Throughout the study, the empirical analysis is conducted using a cross-country sample of commercial banks covering 88 countries, with evidence covering the period 2000-2009 where possible depending on data availability.

The empirical analysis has been conducted with regard to examining the four specific research issues / questions:

(i) Whether the impact of financial liberalisation on bank efficiency and productivity differs across different income groups by classifying them according to high,

upper-middle, lower-middle and lower income groups so as to account for the level economic development?

(ii) Which regulatory and market related factors are important in assessing the significance of the impact of financial liberalisation on bank efficiency and productivity?

(iii) Considering the specific characteristics of the banking system, in particular the importance of moral hazard and limited liability that banks face with regard to their incentives for risk-taking, whether any causal influences can be drawn between financial liberalisation, risk and bank efficiency?

(iv) Whether the impact of financial liberalisation on bank efficiency and risk is affected by accounting appropriately for the degree of competition in the banking sectors?

In addressing these research questions, the empirical results based on frontier analyses have been subject to a number of robustness tests conducted, where appropriate, using: (i) separate frontiers for the four income group countries; (ii) the traditional intermediation approach (which excludes non-interest income), and (iii) variations in the mean inefficiency and regression specifications to account for the impact of financial crises, capital structure (leverage), moral hazard and default risk. Additionally, in addressing the third and fourth research questions above, the empirical analysis is supplemented with dynamic panel data regressions and Granger causality analysis in order to examine the nature of causal links between financial liberalisation, risk, competition and banking sector efficiency.

9.2 Summary of results

The main conclusion that can be drawn from the empirical results is that financial liberalisation exerts an independent and statistically significant effect on banks' cost, profit and overall technical (as well as pure) efficiency, but the effect on scale efficiency and productivity growth is not statistically significant or robust. More specifically, the impact on financial liberalisation on banks' profit efficiency is always positive while the impact on cost efficiency is mixed (positive or negative) dependent on the measure of

financial liberalisation used. Typically, the *de jure* measure (Chinn and Ito, 2008) decreases cost efficiency while the *de facto* measure (Kose et al, 2009) increases cost efficiency. However, this contradictory finding on cost efficiency may be attributed to the use of the global frontier because robustness analysis using separate frontiers confirms that both measures of capital market liberalisation improve cost and profit efficiency in the advanced income group (high and upper-middle) countries, but actually reduce both cost and profit efficiency in the lower-middle income group countries, with the effect being insignificant in the lower income (less developed) countries. On the other hand, robustness analysis using alternative measures of financial liberalisation (Abiad et al, 2005) confirms (using global frontier) that capital account liberalisation decreases cost efficiency while equity market liberalisation increases cost efficiency, the impact on profit efficiency being positive in both cases. Hence, the results on cost efficiency are rather mixed using the global frontier. Additionally, the results show that while cost efficiency remains, on average, stable during the estimation period (2000-2009), average profit efficiency somewhat fluctuates in the pre-crises period (2000-06) but declines sharply during the post crises period (2007-09). The results also show that financial crisis has a negative and statistically significant impact on both cost and profit efficiency. The effect of financial liberalisation on the technical (pure and overall) efficiency is always negative, whichever measure of financial liberalisation is used, with the effect being significant in more developed (higher and middle-income) countries but insignificant in the less developed countries.

With regard to the impact of regulatory factors, the results show that stricter capital requirements improve cost efficiency but reduce profit efficiency, while greater supervisory power and restrictions on bank activities have the opposite effect, reducing cost efficiency but improving profit efficiency. This finding is consistent with most previous research. However, the results show that enhanced private monitoring that imposes stringent market discipline reduces the cost and profit efficiency, in contrast to previous studies (e.g. Pasiouras et al, 2009; Lozano-Vivas and Pasiouras, 2010). Additionally, the impact of regulations on technical efficiency is negative but not always robust (except for activity restrictions). The impact of various market related factors such

as market structure, financial development and macroeconomic conditions is also mainly significant and consistent with most previous research.

Taking account of the specific characteristics of the banking system, concerning the impact of deposit insurance schemes and the default risk of banks, the results show that the existence of deposit insurance as well as higher deposit insurer power reduces bank efficiency (cost, profit and technical) while better quality of legal and political institutions improves efficiency. Similarly, higher default risk is negatively related to bank efficiency. These findings support the *"bad management"* hypothesis (Berger and DeYoung, 1997). Additionally, the results of Granger causality analysis confirm that financial liberalisation, along with lower cost efficiency and higher profit efficiency of banks increase the potential for default risk.

Accounting explicitly for the influence of competition, the results show that higher competition enhances cost efficiency but erodes profit efficiency of banks. The results of Granger causality analysis here confirm that the causal effect between financial liberalisation and competition runs in both directions, implying that greater financial liberalisation intensifies competition and vice-versa. In addition, the results confirm that both financial liberalisation and greater degree of market power of banks Granger-causes higher default risk, providing further support for the bad management hypothesis.

Overall, the effects of financial liberalisation on banks' cost, profit and technical efficiency remain statistically significant and robust after accounting for the influence of deposit insurance, default risk and competition.

9.3 Evaluation and policy recommendations

Many authors (Kaminsky and Schmukler, 2003; Ranciere et al., 2006) have highlighted the benefits of financial liberalisation for long-term economic growth, but also the dangers of rapid liberalisation associated with the increased likelihood of financial crises which adversely affects the real economy. Similarly, the results of this study are intended to highlight that the impact of financial liberalisation on the banking sector is not risk free. While, on one hand, financial liberalisation improves the efficiency of banks, especially in more developed economies, on the other it also induces excessive risk taking in the banking sector due to moral hazard and leads to increased

default risk, consequently having an adverse impact on the efficiency. Hence, there is a trade-off between the impact of financial liberalisation on efficiency and the impact of default risk on efficiency, given that financial liberalisation and efficiency both also have an impact on default risk.

One obvious policy recommendation of this study is that the authorities should counteract the adverse impact of financial liberalisation on excessive risk taking with appropriate regulatory measures such as higher capital adequacy requirements and enhanced supervisory power to mitigate the risk taking implications of both deposit insurance schemes and deposit insurance power, and thereby improve the soundness and efficiency of banks. Particularly, in more developed economies where deposit insurance schemes prevail, the design of a sound regulatory framework and architecture for supervisory conduct is important to counteract the moral hazard implications of bank behaviour in response to policies advocating financial liberalisation. On the other hand, for the less developed economies, where the impact of financial liberalisation is less evident, the need to achieve the economic preconditions, such as better foundation for macroeconomic stability and economic development is more imminent. As io et al. (1996) highlight, the list of what needs to be met before financial deregulation suggests that the following pre-conditions: (i) a stable macroeconomic environment; (ii) soundness of the financial system and the participants; (iii) a minimal base of financial skills; and (iv) effective regulatory measures to limit collusive behaviour among banks. Traditionally, according to Detragiache and Demirgüç-Kunt (1998) (cited in io et al., 2001), deficits in banking skills, supervisory agencies and the legal infrastructure needed for efficient market decisions have meant that liberalisations have encountered many problems.

Another policy implication, given that financial liberalisation has a dual impact on the economy, is the sequencing of financial liberalisation, an issue briefly discussed in Chapter 2. In this context, Rodrik (2006) critically evaluates the debate surrounding the Washington consensus, highlighting the important lessons learnt from the experience of developing countries, and offering competing perspectives on the reform agendas, including the need for institutional change. He argues, in particular, that growth and development strategies should involve a combination of diagnosis and policy design to alleviate constraints on growth across countries.

Finally, and more importantly, the recent global financial crisis has brought to the forefront the importance of accounting for systemic risk, with implications for the design institutional structures to be effectively integrated with macro-prudential regulations for crises prevention (Claessens and Kose, 2013). At the international level, a significant effort has been made for the Basel III accord to add macro-prudential considerations to its traditional micro-prudential focus. According to Gordon and Mayer (2011), the new accord requires that all banks and systemically important financial institutions (SIFIs) hold additional and higher quality capital and make provisions for assessment of risk associated with securitization and financial distress[33].

Seen in the above contexts, this empirical research has highlighted importance of taking into consideration the positive impact that financial liberalisation policies has on banking sector performance but also the negative consequences of excessive risk-taking on efficiency. Hence, it adds to the ongoing debate about the sequencing of reforms and the importance of designing an effective regulatory, institutional and macro-prudential policy framework to help maintain the efficiency and stability of banks.

9.4 Suggestions for future research

While the thesis provides robust evidence that financial liberalisation contributes to the efficient functioning of commercial banks, there are some issues that needs to be addressed in future research. Firstly, the two main measures of financial liberalisation used in this study are the *de jure* index constructed by Chinn and Ito (2008) and the *de facto* measure of Kose et al (2009). Both refer to the capital account liberalisation, although in robustness analysis we incorporated the additional six measures of domestic and international financial liberalisation provided by Abiad et al. (2008). The latter dataset, however, is only available to 2005, thus limiting its use and scope in this study. It is hoped that the future research will, subject to data availability, extend the scope of this research to include a comparison of the effects of capital account and equity market liberalisations, as in Bekaert et al. (2011). Also equally important, is to study the

[33] For example, the new capital requirements is addressed through, firstly, a capital conservation buffer that allows banks to decrease their risk weighed capital ratio from 10.5% to 8% when they face adverse conditions; secondly, a countercyclical capital buffer that a country should implement when it is confronted with excessive credit growth (Gordon and Mayer, 2011).

simultaneous impact of domestic and international financial liberalisations using an econometric framework used by Baltagi et al. (2009) in analysing the relative importance of trade and financial openness on financial development.

Secondly, the measure of risk in this study is the default risk (*z - score*) at bank level and the moral hazard index as a proxy for industry-level risk. The latter is constructed on the basis of the information on deposit insurance schemes, though there is a lot of research which indicates a close relationship between deposit insurance and systemic risk in banking. Indeed, as noted above, the recent financial crises has highlighted the importance of measuring systemic risk in the banking system (Acharya et al., 2012; Weiß et al., 2014). Although there is still little consensus about how to measure systemic risk (see Cerutti et al., 2012), incorporating such a measure in assessing the impact of financial liberalisation on bank efficiency would be a useful extension of this study.

Finally, with regard to the methodology, none of the regression models estimated in this study included any interaction terms, and their inclusion may offer insight into how some of the regulatory and other control variables could yield varying impact on efficiency when interacted with financial liberalisation. Additionally, with regard to sampling issues, there is clear scope for extending the study to include different types of banks (e.g. savings, cooperatives, etc) and to distinguish between ownership types, such as domestic vs. foreign and state-owned vs. private banks.

References

Abiad, A. and Mody, A. (2005). Financial reform: what shakes it? what shapes It? *The American Economic Review* 95 (1), pp.66-88.

Abiad, A., Oomes, N. and Ueda, K. (2008). The quality effect: Does financial liberalization improve the allocation of capital? *Journal of Development Economics* 87 (2), pp.270-282.

Abiad, A., Tressel, T. and Detragiache, E. (2008). *A new database of financial reforms.* International Monetary Fund.

Acharya, V., Pedersen, L., Philippon, T. and Richardson, M. (2012). Measuring systemic risk.

Aigner, D., Lovell, C. A. K. and Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics* 6 (1), pp.21-37.

Alhadeff, D. A. (1954). *Monopoly and competition in banking.* University of California Press.

Allen, F. and Gale, D. (2004). Competition and financial stability.

Altunbas, Y., Carbo, S., Gardener, E. P. M. and Molyneux, P. (2007). Examining the relationships between capital, risk and efficiency in European banking. *European Financial Management* 13 (1), pp.49-70.

Altunbas, Y., Liu, M.-H., Molyneux, P. and Seth, R. (2000). Efficiency and risk in Japanese banking. *Journal of Banking & Finance* 24 (10), pp.1605-1628.

Altunbas, Y., Chakravarty, S.P., (2001). Frontier cost functions and bank efficiency. Economic Letters 72, 233–240.

Altunbaş, Y. and Marqués, D. (2008). Mergers and acquisitions and bank performance in Europe: The role of strategic similarities. *Journal of economics and business* 60 (3), pp.204-222.

Angkinand, A. P., Sawangngoenyuang, W. and Wihlborg, C. (2010). Financial Liberalization and Banking Crises: A Cross-Country Analysis*. *International Review of Finance* 10 (2), pp.263-292.

Angkinand, A. P., Sawangngoenyuang, W. and Wihlborg, C. (2010). Financial liberalization and banking crises: A cross‐country analysis. *International Review of Finance* 10 (2), pp.263-292.

Arellano, M. and Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics* 68 (1), pp.29-51.

Arestis, P. and Caner, A. (2004). Financial liberalization and poverty: Channels of influence.

Arestis, P., Demetriades, P., Fattouh, B. and Mouratidis, K. (2002). The impact of financial liberalization policies on financial development: evidence from developing economics. *International Journal of Finance & Economics* 7 (2), pp.109-121.

Arestis, P., Demetriades, P. O. and Luintel, K. B. (2001). Financial development and economic growth: the role of stock markets. *Journal of money credit and banking* 33 (1), pp.16-41.

Ataullah, A., Cockerill, T. and Le, H. (2004). Financial liberalization and bank efficiency: a comparative analysis of India and Pakistan. *Applied Economics* 36 (17), pp.1915-1924.

Athanasoglou, P. P., Brissimis, S. N. and Delis, M. D. (2008). Bank-specific, industry-specific and macroeconomic determinants of bank profitability. *Journal of International Financial Markets, Institutions and Money* 18 (2), pp.121-136.

Bagehot, W. (1873). Lombard Street: a description of the money market (London: Henry S. King).

Baltagi, B. H., Demetriades, P. O. and Law, S. H. (2009). Financial development and openness: Evidence from panel data. *Journal of Development Economics* 89 (2), pp.285-296.

Bandiera, O., io, G., Honohan, P. and Schiantarelli, F. (2000). Does financial reform raise or reduce saving? *Review of Economics and Statistics* 82 (2), pp.239-263.

Banker, R. D., Charnes, A. and Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management science* 30 (9), pp.1078-1092.

Barrell, R., Karim, D. and Ventouri, A. (2013). Financial liberalization and capital adequacy in models of financial crises. *Economics*.

Barth, J. R., io, G. and Levine, R. (2006). Rethinking bank regulation. *Cambridge Books*.

Barth, J. R., io Jr, G. and Levine, R. (2004). Bank regulation and supervision: what works best? *Bank Capital Adequacy Regulation under the New Basel Accord* 13 (2), pp.205-248.

Barth, J. R., Levine, R. and io Jr, G. (2001). The Regulation and supervision of banks around the world—A new database. *Policy Research Working Paper Series* 2588.

Barth, J. R., Lin, C., Ma, Y., Seade, J. and Song, F. M. (2013). Do bank regulation, supervision and monitoring enhance or impede bank efficiency? *Journal of Banking & Finance* 37 (8), pp.2879-2892.

Battese, G. E. and Coelli, T. J. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics* 20 (2), pp.325-332.

Battese, G. E. and Corra, G. S. (1977). Estimation of a production frontier model: with application to the pastoral zone of eastern Australia. *Australian Journal of Agricultural and Resource Economics* 21 (3), pp.169-179.

Bauer, P. W., Berger, A. N., Ferrier, G. D. and Humphrey, D. B. (1998). Consistency conditions for regulatory analysis of financial institutions: A comparison of frontier efficiency methods. *Journal of economics and business* 50 (2), pp.85-114.

Baumol, W. J. and Braunstein, Y. M. (1977). Empirical study of scale economies and production complementarity: The case of journal publication. *The Journal of Political Economy*, pp.1037-1048.

Baumol, W. J., Panzar, J. C. and Willig, R. D. (1988). *Contestable markets and the theory of industry structure.* San Diego [etc.]: HBJ.

Beck, T. (2003). The incentive-compatible design of deposit insurance and bank failure resolution: concepts and country studies. *World Bank Policy Research Working Paper* (3043).

Beck, T., Demirgüç-Kunt, A. and Levine, R. (2006). Bank concentration, competition, and crises: First results. *Journal of Banking & Finance* 30 (5), pp.1581-1603.

Beck, T., Demirguc-Kunt, A. and Merrouche, O. (2010). *Islamic vs. conventional banking : business model, efficiency and stability.* The World Bank.

Beck, T., Hesse, H., Kick, T. and von Westernhagen, N. (2009). Bank ownership and stability: evidence from Germany. *Tilburg University, Unpublished manuscript*.

Beck, T., Levine, R. and Loayza, N. (2000). Finance and the sources of growth. *Special Issue on International Corporate Governance* 58 (1–2), pp.261-300.

Beim, D. O. and Calomiris, C. W. (2000). Emerging financial markets. *New York, NY, USA: McGraw&Hill/Irwin*.

Beine, M., Cosma, A. and Vermeulen, R. (2010). The dark side of global integration: Increasing tail dependence. *Journal of Banking & Finance* 34 (1), pp.184-192.

Bekaert, G. and Harvey, C. R. (2000). Foreign speculators and emerging equity markets. *The Journal of Finance* 55 (2), pp.565-613.

Bekaert, G., Harvey, C. R. and Lundblad, C. (2005). Does Financial liberalization spur growth. *Journal of Financial Economics*, pp.3-55.

Bekaert, G., Harvey, C. R. and Lundblad, C. (2011). Financial Openness and Productivity. *World Development* 39 (1), pp.1-19.

Ben Naceur, S., Ghazouani, S. and Omran, M. (2008). Does stock market liberalization spur financial and economic development in the MENA region? *Journal of Comparative Economics* 36 (4), pp.673-693.

Bencivenga, V. R. and Smith, B. D. (1991). Financial Intermediation and Endogenous Growth. *The Review of Economic Studies* 58 (2), pp.195-209.

Benston, G. J. (1972). Economies of scale of financial institutions. *Journal of Money, Credit and Banking*, pp.312-341.

Benston, G. J., Hanweck, G. A. and Humphrey, D. B. (1982). Operating costs in commercial banking. *Federal Reserve Bank of Atlanta Economic Review*, pp.pp. 6–21.

Berg, S. A., Førsund, F. R. and Jansen, E. S. (1992). Malmquist indices of productivity growth during the deregulation of Norwegian banking, 1980-89. *The Scandinavian Journal of Economics*, pp.211-228.

Berger, A. (1993). "Distribution-free" estimates of efficiency in the U.S. banking industry and tests of the standard distributional assumptions. *Journal of Productivity Analysis* 4 (3), pp.261-292.

Berger, A. N. (2000). The Integration of the Financial Services Industry. *North American Actuarial Journal* 4 (3), pp.25-45.

Berger, A. N., Clarke, G. R. G., Cull, R., Klapper, L. F. and Udell, G. (2005). Corporate governance and bank performance: A joint analysis of the static, selection, and dynamic effects of domestic, foreign, and state ownership. *Journal of Banking & Finance* 29 (8-9), pp.2179-2221.

Berger, A. N., Cummins, J. D. and Weiss, M. A. (1997). The Coexistence of multiple distribution systems for financial services: The case of property-liability insurance. *The Journal of Business* 70 (4), pp.515-546.

Berger, A. N. and DeYoung, R. (1997). Problem loans and cost efficiency in commercial banks. *Journal of Banking & Finance* 21 (6), pp.849-870.

Berger, A. N. and Hannan, T. H. (1998). The efficiency cost of market power in the banking industry: A eest of the quiet life and related hypotheses. *Review of Economics and Statistics* 80 (3), pp.454-465.

Berger, A. N., Hasan, I. and Zhou, M. (2009). Bank ownership and efficiency in China: What will happen in the world's largest nation? *The Financial Market in China: Issues Related to the Asia Pacific Region, the Financial Services Industry and Corporate Governance International Conference Celebrating the 30th Anniversary of the Journal of Banking and Finance* 33 (1), pp.113-130.

Berger, A. N. and Humphrey, D. B. (1991). The dominance of inefficiencies over scale and product mix economies in banking. *Journal of Monetary Economics* 28 (1), pp.117-148.

Berger, A. N. and Humphrey, D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research* 98 (2), pp.175-212.

Berger, A. N., Hunter, W. C. and Timme, S. G. (1993). The efficiency of financial institutions: A review and preview of research past, present and future. *Special Issue on The Efficiency of Financial Institutions* 17 (2–3), pp.221-249.

Berger, A. N. and Mester, L. J. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions? *Journal of Banking & Finance* 21 (7), pp.895-947.

Berger, A. N. and Mester, L. J. (2003). Explaining the dramatic changes in performance of US banks: technological change, deregulation, and dynamic changes in competition. *Journal of Financial Intermediation* 12 (1), pp.57-95.

Bird, G. and Rajan, R. S. (2001). Banks, financial liberalisation and financial crises in emerging markets. *World Economy* 24 (7), pp.889-910.

Blundell, R. and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics* 87 (1), pp.115-143.

Bofondi, M. and Gobbi, G. (2004). *Bad loans and entry into local credit markets.* Banca d'Italia.

Bonaccorsi di Patti, E. and Hardy, D. C. (2005). Financial sector liberalization, bank privatization, and efficiency: Evidence from Pakistan. *Bank Privatization* 29 (8–9), pp.2381-2406.

Bonfiglioli, A. (2008). Financial integration, productivity and capital accumulation. *Journal of International Economics* 76 (2), pp.337-355.

Bonin, J. P., Hasan, I. and Wachtel, P. (2005). Privatization matters: Bank efficiency in transition countries. *Bank Privatization* 29 (8–9), pp.2155-2178.

Bos, J. W. B. and Koetter, M. (2011). Handling losses in translog profit models. *Applied Economics* 43 (3), pp.307-312.

Boyd, J. H. and De Nicolo, G. (2005). The theory of bank risk taking and competition revisited. *The Journal of Finance* 60 (3), pp.1329-1343.

Boyd, J. H. and Prescott, E. C. (1986). Financial intermediary-coalitions. *Journal of Economic Theory* 38 (2), pp.211-232.

Brissimis, S. N. and Delis, M. D. (2011). Bank-level estimates of market power. *European Journal of Operational Research* 212 (3), pp.508-517.

Broner, F. A. and Ventura, J. (2010). *Rethinking the Effects of Financial Liberalization.* National Bureau of Economic Research, Inc.

Byrne, J. and Wang, Y.-D. (1991). *Toward sustainable energy, environment and development : institutional strategies for Indonesia, South Korea, Malaysia and*

Thailand. [Newark, DE]: Center for Energy and Urban Policy Research, University of Delaware.
Calderon, C. and Liu, L. (2003). The direction of causality between financial development and economic growth. *Journal of Development Economics* 72 (1), pp.321-334.
Caprio, G., Atiyas, I. and Hanson, J. A. (1996). *Financial reform: theory and experience.* Cambridge University Press.
Caprio, G., Honohan, P. and Stiglitz, J. E. (2001). *Financial liberalization: how far, how fast?* Cambridge University Press.
Carkovic, M. and Levine, R. (2002). Finance and growth: New evidence and policy analyses for Chile. *Economic Growth: Sources, Trends, and Cycles, Santiago, Chile: Central Bank of Chile*, pp.343-376.
Casu, B. and Girardone, C. (2006). Bank competition, concentration and efficiency in the single european market. *The Manchester School* 74 (4), pp.441-468.
Casu, B. and Girardone, C. (2009). Testing the relationship between competition and efficiency in banking: A panel data analysis. *Economics Letters* 105 (1), pp.134-137.
Cerutti, E., Claessens, S. and McGuire, P. (2012). Systemic risks in global banking: What available data can tell us and what more data are needed?
Charnes, A., Cooper, W. W. and Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research* 2 (6), pp.429-444.
Chen, C. (2009). Bank Efficiency in Sub-Saharan African Middle Income Countries. *IMF Working Papers*, pp.1-32.
Chen, X., Skully, M. and Brown, K. (2005). Banking efficiency in China: Application of DEA to pre- and post-deregulation eras: 1993–2000. *China Economic Review* 16 (3), pp.229-245.
Chinn, M. D. and Ito, H. (2006). What matters for financial development? Capital controls, institutions, and interactions. *Journal of Development Economics* 81 (1), pp.163-192.
Chinn, M. D. and Ito, H. (2008). A new measure of financial openness. *Journal of Comparative Policy Analysis: Research and Practice* 10 (3), pp.309-322.
Cho, Y. J. (1988). The effect of financial liberalization on the efficiency of credit allocation: Some evidence from Korea. *Journal of Development Economics* 29 (1), pp.101-110.
Chortareas, G. E., Girardone, C. and Ventouri, A. (2012). Bank supervision, regulation, and efficiency: Evidence from the European Union. *Journal of Financial Stability* 8 (4), pp.292-302.
Christopoulos, D. K., Lolos, S. E. G. and Tsionas, E. G. (2002). Efficiency of the Greek banking system in view of the EMU: a heteroscedastic stochastic frontier approach. *Journal of Policy Modeling* 24 (9), pp.813-829.
Christopoulos, D. K. and Tsionas, E. G. (2004). Financial development and economic growth: evidence from panel unit root and cointegration tests. *Journal of Development Economics* 73 (1), pp.55-74.
Claessens, S. and Kose, M. M. A. (2013). *Financial Crises Explanations, Types, and Implications.* International Monetary Fund.

Claessens, S. and Laeven, L. (2004). What drives bank competition? Some international evidence. *Journal of Money, Credit and Banking*, pp.563-583.
Clark, J. A. (1988). Economies of scale and scope at depository financial institutions: A review of the literature. *Economic Review* 73 (8), pp.17-33.
Clark, J. A. and Speaker, P. J. (1994). Economies of scale and scope in banking: evidence from a generalized translog cost function. *Quarterly Journal of Business and Economics*, pp.3-25.
Coelli, T. J. (1996). *A guide to FRONTIER version 4.1: A computer program for stochastic frontier production and cost function estimation*.
Coelli, T. J., Rao, D. S. P., O'Donnell, C. J. and Battese, G. E. (2005). *An introduction to efficiency and productivity analysis.* Springer.
Cordella, T. and Yeyati, E. L. (2002). Financial opening, deposit insurance, and risk in a model of banking competition. *European Economic Review* 46 (3), pp.471-485.
Craigwell, R., Greenidge, K. and Williams, M. (2007). *Aspects of Financial Liberalisation and Capital Market Development in the Caribbean.* Central Bank of Barbados.
Cubillas, E. and González, F. (2013). Financial liberalization and bank risk-taking: International evidence. *Journal of Financial Stability* (0).
Cull, R. J., Senbet, L. W. and Sorge, M. (2005). Deposit insurance and financial development. *Journal of Money, Credit, and Banking* 37 (1), pp.43-82.
Daniel, B. C. and Jones, J. B. (2007). Financial liberalization and banking crises in emerging economies. *Journal of International Economics* 72 (1), pp.202-221.
Delis, M. D. (2012). Bank competition, financial reform, and institutions: The importance of being developed. *Journal of Development Economics* 97 (2), pp.450-465.
Delis, M. D., Molyneux, P. and Pasiouras, F. (2011). Regulations and Productivity Growth in Banking: Evidence from Transition Economies. *Journal of Money, Credit and Banking* 43 (4), pp.735-764.
Delis, M. D. and Tsionas, E. G. (2009). The joint estimation of bank-level market power and efficiency. *Micro and Macro Foundations of International Financial Integration International Financial Integration* 33 (10), pp.1842-1850.
Dell'Ariccia, G. and Marquez, R. (2006). Lending booms and lending standards. *The Journal of Finance* 61 (5), pp.2511-2546.
DeLong, G. and Saunders, A. (2011). Did the introduction of fixed-rate federal deposit insurance increase long-term bank risk-taking? *Journal of Financial Stability* 7 (1), pp.19-25.
Demetriades, P. O. and Luintel, K. B. (1996). Banking sector policies and financial development in Nepal. *Oxford Bulletin of Economics and Statistics* 58 (2), pp.355-372.
Demetriades, P. O. and Luintel, K. B. (1997). The direct costs of financial repression: evidence from India. *Review of Economics and Statistics* 79 (2), pp.311-320.
Demirgüç-Kunt, A. and Detragiache, E. (2002). Does deposit insurance increase banking system stability? An empirical investigation. *Journal of Monetary Economics* 49 (7), pp.1373-1406.
Demirgüç-Kunt, A. and Huizinga, H. (1999). Determinants of commercial bank interest margins and profitability: Some international evidence. *The World Bank Economic Review* 13 (2), pp.379-408.

Demirgüç-Kunt, A. and Huizinga, H. (2004). Market discipline and deposit insurance. *Journal of Monetary Economics* 51 (2), pp.375-399.
Demirgüç-Kunt, A., Karacaovali, B. and Laeven, L. (2005). Deposit insurance around the world: A comprehensive database. *World Bank Policy Research Working Paper* (3628).
Demirguc-Kunt, A. and Kane, E. J. (2002). Deposit insurance around the globe: Where does it work? *The Journal of Economic Perspectives* 16 (2), pp.175-195.
Demsetz, H. (1973). *The market concentration doctrine; an examination of evidence and a discussion of policy.* Washington: American Enterprise Institute for Public Policy Research.
Demsetz, R., Saidenberg, M. and Strahan, P. (1996). Banks with something to lose: The disciplinary role of franchise value. *Economic Policy Review* 2 (2).
Denizer, C., Dinc, M. and Tarimcilar, M. (2007). Financial liberalization and banking efficiency: evidence from Turkey. *Journal of Productivity Analysis* 27 (3), pp.177-195.
Detragiache, E. and Demirgüç-Kunt, A. (1998). *Financial liberalization and financial fragility.* International Monetary Fund.
DeYoung, R., Hasan, I., (1998). The performance of de novo commercial banks: A profit efficiency approach. *Journal of Banking and Finance* 22, 565–587.
Diamond, D. W. (1984). Financial intermediation and delegated monitoring. *The Review of Economic Studies* 51 (3), pp.393-414.
Diamond, D. W. and Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *The Journal of Political Economy*, pp.401-419.
Diaz-Alejandro, C. (1985). Good-bye financial repression, hello financial crash. *Journal of Development Economics* 19 (1–2), pp.1-24.
Dietsch, M. and Lozano-Vivas, A. (2000). How the environment determines banking efficiency: A comparison between French and Spanish industries. *Journal of Banking & Finance* 24 (6), pp.985-1004.
Dogan, E. and Fausten, D. (2003). Productivity and technical change in Malaysian banking: 1989–1998. *Asia-Pacific Financial Markets* 10 (2-3), pp.205-237.
Doyle, J. and Green, R. (1994). Efficiency and cross-efficiency in DEA: Derivations, meanings and uses. *Journal of the operational research society*, pp.567-578.
Edison, H. J. and Warnock, F. E. (2003). A simple measure of the intensity of capital controls. *Journal of Empirical Finance* 10 (1–2), pp.81-103.
Eichengreen, B. (2001). Capital account liberalization: what do cross ‐ country studies tell us? *The World Bank Economic Review* 15 (3), pp.341-365.
Enisan, A. A. and Olufisayo, A. O. (2009). Stock market development and economic growth: Evidence from seven sub-Sahara African countries. *Journal of economics and business* 61 (2), pp.162-171.
Färe, R., Grosskopf, S., Norris, M. and Zhang, Z. (1994). Productivity growth, technical progress, and efficiency change in industrialized countries. *The American Economic Review*, pp.66-83.
Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society. Series A (General)* 120 (3), pp.253-290.
Feridun, M. (2007). Financial liberalization and currency crises: the case of Turkey. *Banks and Bank Systems* 2 (2), pp.44-68.

Fernandez de Guevara, J., Maudos, J. and Perez, F. (2005). Market power in European banking sectors. *Journal of Financial Services Research* 27 (2), pp.109-137.

Ferrier, G. D. and Lovell, C. A. K. (1990). Measuring cost efficiency in banking: Econometric and linear programming evidence. *Journal of Econometrics* 46 (1–2), pp.229-245.

Fiordelisi, F., Marques-Ibanez, D. and Molyneux, P. (2011). Efficiency and risk in European banking. *Journal of Banking & Finance* 35 (5), pp.1315-1326.

Fiordelisi, F., Marques, D. and Molyneux, P. (2009). *Efficiency and Risk-Taking in European Banking.*

Fixler, D. and Zieschang, K. (1992). Incorporating ancillary measures of process and quality change into a superlative productivity index. *Journal of Productivity Analysis* 2 (4), pp.245-267.

Fries, S. and Taci, A. (2005). Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries. *Banking and the Financial Sector in Transition and Emerging Market Economies* 29 (1), pp.55-81.

Fry, M. J. (1980). Money, interest, inflation and growth in Turkey. *Journal of Monetary Economics* 6 (4), pp.535-545.

Gaganis, C. and Pasiouras, F. (2013). Financial supervision regimes and bank efficiency: International evidence. *Journal of Banking & Finance* 37 (12), pp.5463-5475.

Galindo, A., Schiantarelli, F. and Weiss, A. (2007). Does financial liberalization improve the allocation of investment?: Micro-evidence from developing countries. *Journal of Development Economics* 83 (2), pp.562-587.

Gehringer, A. (2012). Growth, productivity and capital accumulation: The effects of financial liberalization in the case of European integration. *International Review of Economics & Finance* 25 (0), pp.291-309.

Gehringer, A. (2013). Financial liberalization, financial development and productivity growth – an overview. *Economics: The Open-Access, Open Assessment E-Journal* 7 (2013-46).

Gehringer, A. (2013). *Financial liberalization, financial development and productivity growth: An overview.* Economics Discussion Papers.

Gilbert, R. A. and Wilson, P. W. (1998). Effects of deregulation on the productivity of Korean banks. *Journal of economics and business* 50 (2), pp.133-155.

Giovannini, A. and Melo, M. d. (1993). Government revenue from financial repression. *The American Economic Review* 83 (4), pp.953-963.

Girardone, C., Molyneux, P. and Gardener, E. P. M. (2004). Analysing the determinants of bank efficiency: the case of Italian banks. *Applied Economics* 36 (3), pp.215-227.

Glick, R. and Hutchison, M. M. (1999). *Banking and Currency Crises: How Common are Twins?* Federal Reserve Bank of San Francisco.

González, F. (2005). Bank regulation and risk-taking incentives: An international comparison of bank risk. *Journal of Banking & Finance* 29 (5), pp.1153-1184.

Gordon, J. and Mayer, C. (2011). The micro, macro and international design of financial regulation. *Columbia Law School, Columbia University*.

Greenbaum, S. I. (1967). Competition and Efficiency in the Banking System--Empirical Research and Its Policy Implications. *The Journal of Political Economy* 75 (4), pp.461-479.

Greene, W. H. (2000). *Econometric analysis 4th edition.* Macmillan.
Greenwood, J. and Jovanovic, B. (1989). *Financial development, growth, and the distribution of income.* National Bureau of Economic Research.
Grifell-Tatje, E. and Lovell, C. A. K. (1996). Deregulation and productivity decline: the case of Spanish savings banks. *European Economic Review* 40 (6), pp.1281-1303.
Griffith-Jones, S. and Gottschalk, R. (2006). Costs of currency crises and benefits of international financial reform. *Currently available from www. stephanygj. com*.
Grigorian, D. A. and Manole, V. (2002). Determinants of commercial bank performance in transition: an application of data envelopment analysis. *World Bank Policy Research Working Paper* (2850).
Grilli, V. and Milesi-Ferretti, G. M. (1995). Economic effects and structural determinants of capital controls. *IMF Staff Papers* 42 (3), pp.517-551.
Gupta, K. and Lensink, R. (2002). *Financial liberalization and investment.* Routledge.
Gupta, K. L. (1987). Aggregate savings, financial intermediation, and interest rate. *The review of economics and statistics*, pp.303-311.
Gwartney, J., Lawson, R. and Hall, J. (2011). 2011 Economic Freedom Dataset, published in Economic Freedom of the World: 2011 Annual Report. *Economic Review* 11 (3), pp.165-178.
Hancock, D. (1985). The financial firm: Production with monetary and nonmonetary goods. *The Journal of Political Economy* 93 (5), pp.859-880.
Hancock, D. (1991). *A theory of production for the financial firm.* Springer.
Harker, P. T. and Zenios, S. A. (2000). What drives the performance of financial institutions?'. *Performance of Financial Institutions: Efficiency, Innovation, Regulation*, pp.3-31.
Hasan, I. and Lozano–Vivas, A. (2002). Organizational form and expense preference: Spanish experience. *Bulletin of Economic Research* 54 (2), pp.135-150.
Hassan, M. K., Sanchez, B. and Yu, J.-S. (2011). Financial development and economic growth: New evidence from panel data. *The Quarterly Review of Economics and Finance* 51 (1), pp.88-104.
Hellmann, T. F., Murdock, K. C. and Stiglitz, J. E. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough? *American Economic Review*, pp.147-165.
Hermes, N. and Lensink, R. (2008). *Does financial liberalization influence saving, investment and economic growth: evidence from 25 emerging market economies, 1973-1996.* ULB -- Universite Libre de Bruxelles.
Hermes, N. and Nhung, V. T. H. (2010). The impact of financial liberalization on bank efficiency: evidence from Latin America and Asia. *Applied Economics* 42 (26), pp.3351-3365.
Hicks, J. R. (1935). Annual survey of economic theory: the theory of monopoly. *Econometrica: Journal of the Econometric Society*, pp.1-20.
Holmström, B. and Tirole, J. (1993). Market liquidity and performance monitoring. *Journal of Political Economy*, pp.678-709.
Hon Chu, K. (2011). Deposit insurance and banking stability. *Cato J.* 31, p.99.
Horvath, R., Seidler, J. and Weill, L. (2012). *Bank Capital and Liquidity Creation: Granger Causality Evidence*.

Hovakimian, A. and Kane, E. J. (2000). Effectiveness of capital regulation at U.S. commercial banks, 1985 to 1994. *The Journal of Finance* 55 (1), pp.451-468.
Hughes, J. and Mester, L. (2008). Efficiency in banking: theory, practice, and evidence.
Hughes, J. P. and Mester, L. J. (1993). A quality and risk-adjusted cost function for banks: Evidence on the too-big-to-fail doctrine. *Journal of Productivity Analysis* 4 (3), pp.293-315.
Humphrey, D. B. and Pulley, L. B. (1997). Banks' responses to deregulation: Profits, technology, and efficiency. *Journal of Money, Credit, and Banking*, pp.73-93.
Hunter, W. C. and Timme, S. G. (1991). Technological change in large US commercial banks. *Journal of Business*, pp.339-362.
Imai, M. (2006). Market discipline and deposit insurance reform in Japan. *Journal of Banking & Finance* 30 (12), pp.3433-3452.
Ioannidou, V. P. and Penas, M. F. (2010). Deposit insurance and bank risk-taking: Evidence from internal loan ratings. *Journal of Financial Intermediation* 19 (1), pp.95-115.
Isik, I. and Hassan, M. K. (2003). Financial deregulation and total factor productivity change: An empirical study of Turkish commercial banks. *Journal of Banking & Finance* 27 (8), pp.1455-1485.
Jeitschko, T. D. and Jeung, S. D. (2005). Incentives for risk-taking in banking – A unified approach. *Journal of Banking & Finance* 29 (3), pp.759-777.
Jensen, M. C. and Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics* 3 (4), pp.305-360.
Jensen, M. C. and Murphy, K. J. (1990). Performance pay and top-management incentives. *The Journal of Political Economy* 98 (2), pp.225-264.
Jiménez, G., Lopez, J. A. and Salas, J. S. (2010). *How does competition impact bank risk-taking?* Banco de España.
Jondrow, J., Knox Lovell, C. A., Materov, I. S. and Schmidt, P. (1982). On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of Econometrics* 19 (2–3), pp.233-238.
Kalish Iii, L. and Gilbert, R. A. (1973). An analysis of efficiency of scale and organizational form in commercial banking. *The Journal of Industrial Economics*, pp.293-307.
Kaminsky, G. and Schmukler, S. (2003). *Short-run pain, long-run gain: the effects of financial liberalization.* National Bureau of Economic Research.
Kaminsky, G. L. and Reinhart, C. M. (1999). The twin crises: the causes of banking and balance-of-payments problems. *American Economic Review*, pp.473-500.
Kasman, A. and Yildirim, C. (2006). Cost and profit efficiencies in transition banking: the case of new EU members. *Applied Economics* 38 (9), pp.1079-1090.
Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking. *The American Economic Review*, pp.1183-1200.
Keeley, M. C. and Furlong, F. T. (1990). A reexamination of mean-variance analysis of bank capital regulation. *Journal of Banking & Finance* 14 (1), pp.69-84.
King, R. G. and Levine, R. (1993). Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics* 108 (3), pp.717-737.

Klein, M. W. and Olivei, G. P. (2008). Capital account liberalization, financial depth, and economic growth. *Journal of International Money and Finance* 27 (6), pp.861-875.

Kose, M. A., Prasad, E., Rogoff, K. and Wei, S.-J. (2009). Financial globalization: A reappraisal. *IMF Staff Papers* 56 (1), pp.8-62.

Kose, M. A., Prasad, E. S. and Terrones, M. E. (2009). Does openness to international financial flows raise productivity growth? *Journal of International Money and Finance* 28 (4), pp.554-580.

Kraay, A. (1998). In search of the macroeconomic effects of capital account liberalization. *World Bank*.

Kukenova, M. (2011). Financial liberalization and allocative efficiency of capital. *World Bank Policy Research Working Paper Series, Vol*.

Kumar, S. and Gulati, R. (2010). Dynamics of cost efficiency in Indian Public Sector Banks: a post-deregulation experience. In: *Submitted for presentation in the Twelfth Annual Conference on Money and Finance in the Indian Economy, 11th and 12th March*.

Kumbhakar, S. C. and Lovell, C. A. K. (2000). *Stochastic frontier analysis.* Cambridge [etc.]: Cambridge University Press.

Kumbhakar, S. C., Lozano-Vivas, A. N. A., Knox Lovell, C. A. and Hasan, I. (2001). The effects of deregulation on the performance of financial institutions: The case of spanish savings banks. *Journal of Money, Credit & Banking (Ohio State University Press)* 33 (1), pp.101-120.

Kuncic, A. (2012). *Institutional quality database*.

Kwan, S. and Eisenbeis, R. A. (1997). Bank risk, capitalization, and operating efficiency. *Journal of Financial Services Research* 12 (2), pp.117-131.

Laeven, L. (2002). Bank risk and deposit insurance. *The World Bank Economic Review* 16 (1), pp.109-137.

Laeven, L. (2003). Does financial liberalization reduce financing constraints? *Financial Management* 32 (1), pp.5-34.

Laeven, L. and Levine, R. (2009). Bank governance, regulation and risk taking. *Journal of Financial Economics* 93 (2), pp.259-275.

Laeven, L. and Valencia, F. (2008). Systemic banking crises: a new database. *IMF Working Papers*, pp.1-78.

Laeven, L. and Valencia, F. (2012). Systemic banking crises database: An update.

Lane, P. R. and Milesi-Ferretti, G. M. (2007). The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970–2004. *Journal of International Economics* 73 (2), pp.223-250.

Leibenstein, H. (1966). Allocative efficiency vs." X-efficiency". *The American Economic Review*, pp.392-415.

Lensink, R., Meesters, A. and Naaborg, I. (2008). Bank efficiency and foreign ownership: Do good institutions matter? *Journal of Banking & Finance* 32 (5), pp.834-844.

Lerner, A. P. (1934). The concept of monopoly and the measurement of monopoly power. The Review of Economic Studies 1 (3), pp.157-175.

Levchenko, A. A., Ranciè re, R. and Thoenig, M. (2009). Growth and risk at the industry level: The real effects of financial liberalization. *New Approaches to Financial Globalization* 89 (2), pp.210-222.

Levine, R. (1997). Financial development and economic growth: views and agenda. *Journal of economic literature*, pp.688-726.
Levine, R. (2001). International financial liberalization and economic growth. *Review of international Economics* 9 (4), pp.688-702.
Levine, R. (2005). Bank regulation and supervision. *NBER Reporter Online* (Fall 2005), pp.9-12.
Levine, R., Loayza, N. and Beck, T. (2000). Financial intermediation and growth: Causality and causes. *Journal of Monetary Economics* 46 (1), pp.31-77.
Levine, R. and Zervos, S. (1996). Stock market development and long-run growth. *The World Bank Economic Review* 10 (2), pp.323-339.
Levine, R. and Zervos, S. (1998). Stock markets, banks, and economic growth. *American Economic Review*, pp.537-558.
Liu, H., Molyneux, P. and Wilson, J. O. S. (2010). Competition and stability in European banking: a regional analysis. *The Manchester School*.
Lovell, C. A. K., Grosskopf, S., Ley, E., Pastor, J., Prior, D. and Eeckaut, P. (1994). Linear programming approaches to the measurement and analysis of productive efficiency. *Top* 2 (2), pp.175-248.
Lozano-Vivas, A. and Pasiouras, F. (2010). The impact of non-traditional activities on the estimation of bank efficiency: International evidence. *Performance Measurement in the Financial Services Sector* 34 (7), pp.1436-1449.
Lozano-Vivas, A. and Pasiouras, F. (2010). The impact of non-traditional activities on the estimation of bank efficiency: International evidence. *Journal of Banking & Finance* 34 (7), pp.1436-1449.
Lozano-Vivas, A. and Pasiouras, F. (2013). Bank Productivity Change and Off-Balance-Sheet Activities Across Different Levels of Economic Development. *Journal of Financial Services Research*, pp.1-24.
Lozano-Vivas, A., Pastor, J. T. and Hasan, I. (2001). European bank performance beyond country borders: What really matters?. *European Finance Review* 5 (1-2), pp.141-165.
Maghyereh, A. (2004). The effect of financial liberalization on the efficiency of financial institutions: the case of Jordanian commercial banks. *Journal of Transnational Management Development* 9 (2-3), pp.71-106.
Matthews, K. and Ismail, M. (2006). Efficiency and productivity growth of domestic and foreign dommercial banks in Malaysia. *Cardiff Economics Working Papers E2006/2, Cardiff University, Cardiff Business School, Economics Section.*
Maudos, J. n., Pastor, J. M., Pérez, F. and Quesada, J. (2002). Cost and profit efficiency in European banks. *Journal of International Financial Markets, Institutions and Money* 12 (1), pp.33-58.
Maudos, J. and de Guevara, J. F. (2007). The cost of market power in banking: Social welfare loss vs. cost inefficiency. Journal of Banking & Finance 31 (7), pp.2103-2125.
Maysami, R. C. and Sakellariou, C. (2008). Financial liberalization, deposit insurance and bank stability. *Applied Economics Letters* 15 (10), pp.743-747.
McDonald, J. (2009). Using least squares and tobit in second stage DEA efficiency analyses. *European Journal of Operational Research* 197 (2), pp.792-798.

McKinnon, R. I. (1973). *Money and capital in economic development.* Brookings Institution Press.
McKinnon, R. I. (1993). *The order of economic liberalization: Financial control in the transition to a market economy.* Johns Hopkins University Press.
McKinnon, R. I. and Pill, H. (1997). Credible economic liberalizations and overborrowing. *The American Economic Review* 87 (2), pp.189-193.
Meeusen, W. and van Den Broeck, J. (1977). Efficiency estimation from Cobb-Douglas production functions with composed error. *International Economic Review* 18 (2), pp.435-444.
Mehrez, G. and Kaufmann, D. (2000). Transparency, liberalization, and financial crisis. *World Bank Policy Research Working Paper* (2286).
Menkhoff, L. and Suwanaporn, C. (2007). 10 Years after the crisis: Thailand's financial system reform. *Journal of Asian Economics* 18 (1), pp.4-20.
Merton, R. C. (1977). An analytic derivation of the cost of deposit insurance and loan guarantees An application of modern option pricing theory. *Journal of Banking & Finance* 1 (1), pp.3-11.
Mester, L. J. (1994). How efficient are third district banks? *Business Review* 1, pp.3-18.
Mester, L. J. (1996). A study of bank efficiency taking into account risk-preferences. *Journal of Banking & Finance* 20 (6), pp.1025-1045.
Mishkin, F. S. (2001). *Financial Policies and the Prevention of Financial Crises in Emerging Market Countries.* National Bureau of Economic Research.
Mitchell, K. and Onvural, N. M. (1996). Economies of Scale and Scope at Large Commercial Banks: Evidence from the Fourier Flexible Functional Form. *Journal of Money, Credit & Banking (Ohio State University Press)* 28 (2), pp.178-199.
Montiel, P. and Reinhart, C. M. (1999). Do capital controls and macroeconomic policies influence the volume and composition of capital flows? Evidence from the 1990s. *Journal of International Money and Finance* 18 (4), pp.619-635.
Moon, C.-G. and Hughes, J. P. (1997). *Measuring Bank Efficiency When Managers Trade Return for Reduced Risk.* Rutgers University, Department of Economics.
Mukherjee, K., Ray, S. C. and Miller, S. M. (2001). Productivity growth in large US commercial banks: The initial post-deregulation experience. *Journal of Banking & Finance* 25 (5), pp.913-939.
Naceur, S. B. and Omran, M. (2011). The effects of bank regulations, competition, and financial reforms on banks' performance. *Emerging Markets Review* 12 (1), pp.1-20.
Nakane, M. I. and Weintraub, D. B. (2005). Bank privatization and productivity: Evidence for Brazil. *Bank Privatization* 29 (8–9), pp.2259-2289.
Nier, E. and Baumann, U. (2006). Market discipline, disclosure and moral hazard in banking. *Basel II: Accounting, Transparency and Bank Stability* 15 (3), pp.332-361.
Noy, I. (2004). Financial liberalization, prudential supervision, and the onset of banking crises. *Emerging Markets Review* 5 (3), pp.341-359.
Park, K. H. (2009). Has bank consolidation in Korea lessened competition? *The Quarterly Review of Economics and Finance* 49 (2), pp.651-667.

Pasiouras, F. (2008). International evidence on the impact of regulations and supervision on banksâ€™ technical efficiency: an application of two-stage data envelopment analysis. *Review of Quantitative Finance and Accounting* 30 (2), pp.187-223.
Pasiouras, F. (2008). International evidence on the impact of regulations and supervision on banks' technical efficiency: an application of two-stage data envelopment analysis. *Review of Quantitative Finance and Accounting* 30 (2), pp.187-223.
Pasiouras, F., Tanna, S. and Zopounidis, C. (2007). Regulations, Supervision and Banks' Cost and Profit Efficiency Around the World: A Stochastic Frontier Approach. *University of Bath Management Working Paper* (2007.05).
Pasiouras, F., Tanna, S. and Zopounidis, C. (2009). The impact of banking regulations on banks' cost and profit efficiency: Cross-country evidence. *International Review of Financial Analysis* 18 (5), pp.294-302.
Pastor, J., Pérez, F. and Quesada, J. (1997). Efficiency analysis in banking firms: An international comparison. *European Journal of Operational Research* 98 (2), pp.395-407.
Patrick, H. T. (1966). Financial development and economic growth in underdeveloped countries. *Economic Development and Cultural Change* 14 (2), pp.174-189.
Perry, P. (1992). Do banks gain or lose from inflation. *Journal of Retail Banking* 14 (2), pp.25-30.
Pitt, M. M. and Lee, L.-F. (1981). The measurement and sources of technical inefficiency in the Indonesian weaving industry. *Journal of Development Economics* 9 (1), pp.43-64.
Prasad, E. and Wei, S.-J. (2007). The Chinese approach to capital inflows: patterns and possible explanations*Capital Controls and Capital Flows in Emerging Economies: Policies, Practices and Consequences*. University of Chicago Press, pp.421-480.
Quinn, D. (1997). The correlates of change in international financial regulation. *American Political Science Review*, pp.531-551.
Quintyn, M. and Taylor, M. W. (2003). Regulatory and supervisory independence and financial stability. *CESifo Economic Studies* 49 (2), pp.259-294.
Rajan, R. G. and Zingales, L. (1998). Financial dependence and growth. *The American Economic Review* 88 (3), pp.559-586.
Ranciere, R. and Tornell, A. (2011). Financial liberalization: efficiency gains and black-holes.
Ranciere, R., Tornell, A. and Westermann, F. (2006). Decomposing the effects of financial liberalization: Crises vs. growth. *Journal of Banking & Finance* 30 (12), pp.3331-3348.
Ranciere, R., Tornell, A. and Westermann, F. (2008). financial liberalization. In: Durlauf, S. N. and Blume, L. E. (eds.) *The New Palgrave Dictionary of Economics*. Basingstoke: Palgrave Macmillan.
Reifschneider, D. and Stevenson, R. (1991). Systematic departures from the frontier: A framework for the analysis of firm inefficiency. *International Economic Review*, pp.715-723.
Reinhart, C. M. and Sbrancia, M. B. (2011). *The liquidation of government debt.* National Bureau of Economic Research.

Resti, A. (1997). Evaluating the cost-efficiency of the Italian banking system: What can be learned from the joint application of parametric and non-parametric techniques. *Journal of Banking & Finance* 21 (2), pp.221-250.

Rossi, S.P.S., Schwaiger, M.S., Winkler, G., (2009). *How loan portfolio diversificationaffects risk, efficiency and capitalization: A managerial behavior model for Austrian banks*. Journal of Banking and Finance 33, 2218–2226.

Rodrik, D. (2006). Goodbye Washington consensus, hello washington confusion? A review of the world bank's economic growth in the 1990s: Learning from a decade of reform. *Journal of economic literature* 44 (4), pp.973-987.

Rodrik, D. and Subramanian, A. (2009). Why did financial globalization disappoint. *IMF Staff Papers* 56 (1), pp.112-138.

Rogers, K. E. (1998). Nontraditional activities and the efficiency of US commercial banks. *Journal of Banking & Finance* 22 (4), pp.467-482.

Rousseau, P. L. and Wachtel, P. (2011). What is happening to the impact of financial deepening on economic growth? *Economic inquiry* 49 (1), pp.276-288.

Roychoudhury, S. and Lawson, R. A. (2010). Economic freedom and sovereign credit ratings and default risk. *Journal of Financial Economic Policy* 2 (2), pp.149-162.

Salas, V. and Saurina, J. (2003). Deregulation, market power and risk behaviour in Spanish banks. *European Economic Review* 47 (6), pp.1061-1075.

Schaeck, K. and Cihak, M. (2008). How does competition affect efficiency and soundness in banking? New empirical evidence.

Schaeck, K. and Cih a k, M. (2014). Competition, efficiency, and stability in banking. Financial Management 43 (1), pp.215-241.Schumpeter, J. A. (1911). The Theory of Economic Development. *Cambridge, MA: Harvard University Press*.

Schweiger, I. and McGee, J. S. (1961). Chicago banking. *Journal of Business*, pp.203-366.

Sealey, C. W. and Lindley, J. T. (1977). Inputs, outputs, and a theory of production and cost at depository financial institutions. *The Journal of Finance* 32 (4), pp.1251-1266.

Semih Yildirim, H. and Philippatos, G. C. (2007). Efficiency of banks: recent evidence from the transition economies of Europe, 1993–2000. *The European Journal of Finance* 13 (2), pp.123-143.

Sensarma, R. (2006). Are foreign banks always the best? Comparison of state-owned, private and foreign banks in India. *Economic Modelling* 23 (4), pp.717-735.

Shaw, E. S. (1973). *Financial deepening in economic development.* New York : Oxford University Press.

Shehzad, C. and Haan, J. (2009). Financial reform and banking crises. *Available at SSRN 1354308*.

Stern, G. H. and Feldman, R. J. (2004). *Too big to fail: The hazards of bank bailouts.* Brookings Inst Press.

Stiglitz, J. E. (1972). Some aspects of the pure theory of corporate finance: bankruptcies and take-overs. *The Bell Journal of Economics and Management Science*, pp.458-482.

Tabak, B. M., Fazio, D. M. and Cajueiro, D. O. (2011). *Profit, Cost and Scale Efficiency for Latin American Banks: Concentration-Performance Relationship.* Central Bank of Brazil, Research Department.

Tanna, S. (2009). The impact of foreign direct investment on total factor productivity growth: International evidence from the banking industry. *Managerial Finance* 35 (3), pp.297-311.

Tirtiroglu, D., Daniels, K. N. and Tirtiroglu, E. (2005). Deregulation, intensity of competition, industry evolution, and the productivity growth of US commercial banks. *Journal of Money, Credit, and Banking* 37 (2), pp.339-360.

Tornell, A., Westermann, F. and Martínez, L. (2003). Liberalization, growth, and financial crises: Lessons from Mexico and the developing world. *Brookings Papers on Economic Activity* 2003 (2), pp.1-112.

Turk Ariss, R. (2010). On the implications of market power in banking: Evidence from developing countries. *Interaction Of Market And Credit Risk* 34 (4), pp.765-775.

Umutlu, M., Akdeniz, L. and Altay-Salih, A. (2010). The degree of financial liberalization and aggregated stock-return volatility in emerging markets. *Journal of Banking & Finance* 34 (3), pp.509-521.

VanHoose, D. (2007). Theories of bank behavior under capital regulation. *Journal of Banking & Finance* 31 (12), pp.3680-3697.

Vivas, A. L. (1997). Profit efficiency for Spanish savings banks. *European Journal of Operational Research* 98 (2), pp.381-394.

Vu, H. and Turnell, S. (2011). Cost and profit efficiencies of Australian banks and the impact of the global financial crisis. *Economic Record* 87 (279), pp.525-536.

Wang, H.-j. and Schmidt, P. (2002). *One-Step and Two-Step Estimation of the Effects of Exogenous Variables on Technical Efficiency Levels.* Springer Netherlands.

Weiß, G. N. F., Neumann, S. and Bostandzic, D. (2014). Systemic risk and bank consolidation: International evidence. *Journal of Banking & Finance* 40 (0), pp.165-181.

Weill, L. (2004). On the relationship between competition and efficiency in the EU banking sectors. *Kredit und Kapital*, pp.329-352.

Wheelock, D. C. and Wilson, P. W. (1999). Technical progress, inefficiency, and productivity change in US banking, 1984-1993. *Journal of Money, Credit, and Banking*, pp.212-234.

Williams, J. (2004). Determining management behaviour in European banking. *Journal of Banking & Finance* 28 (10), pp.2427-2460.

Williams, J. (2012). Efficiency and market power in Latin American banking. *Journal of Financial Stability* 8 (4), pp.263-276.

Williams, J. and Intarachote, T. (2002). Financial liberalisation and profit efficiency in the Thai banking system, 1990–1997: The case of domestic and foreign banks. *Research Paper. University of Wales, Bangor: School for Business and Regional Development*.

Williamson, J. (1990). What Washington means by policy reform. *Latin American adjustment: How much has happened* 1.

Williamson, J. and Mahar, M. (1998). *A survey of financial liberalization.* Essays in international finance. Princeton, N.J.: International Finance Section, Dept. of Economics, Princeton University.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics* 126 (1), pp.25-51.

Worthington, A. C. (1999). Malmquist indices of productivity change in Australian financial services. *Journal of International Financial Markets, Institutions and Money* 9 (3), pp.303-320.

Yeyati, E. L. and Micco, A. (2007). Concentration and foreign penetration in Latin American banking sectors: Impact on competition and risk. *Journal of Banking & Finance* 31 (6), pp.1633-1647.